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ABSTRACT

Ten lessons on air and air pollution comprise this guide for secondary school teachers. Among the topics addressed are pollutants, health effects, weather inversions, personal involvement, and automobile emissions. Particular emphasis is placed upon problems in Alaskan cities. Lesson plans contain a materials list, background information, questions, and activities. The materials can be used in conjunction with classes in health, government, science, and social studies; suggested follow-up activities involve skills developed in art, English, drama, and library classes. A list of field trip sites and teacher resources is included. (Author/WB)

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CLEAN AIR

for

ANCHORAGE and FAIRBANKS

Curriculum for Grades 7-12

SE 035 430

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South East Regional Resource Center

SERRC

Phone 586-6806, 586-6807
538 Willoughby Avenue
Juneau, Alaska 99801

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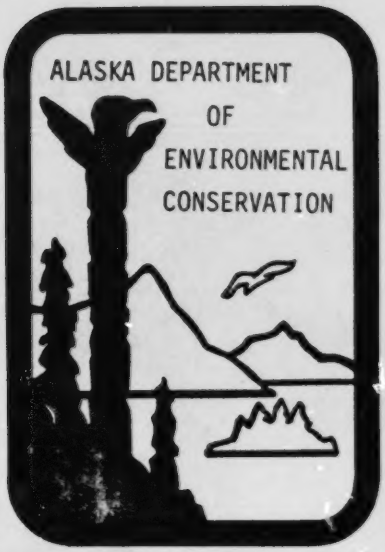

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Juneau, Alaska 99811

Jay S. Hammond
Governor

Ernst W. Mueller
Commissioner

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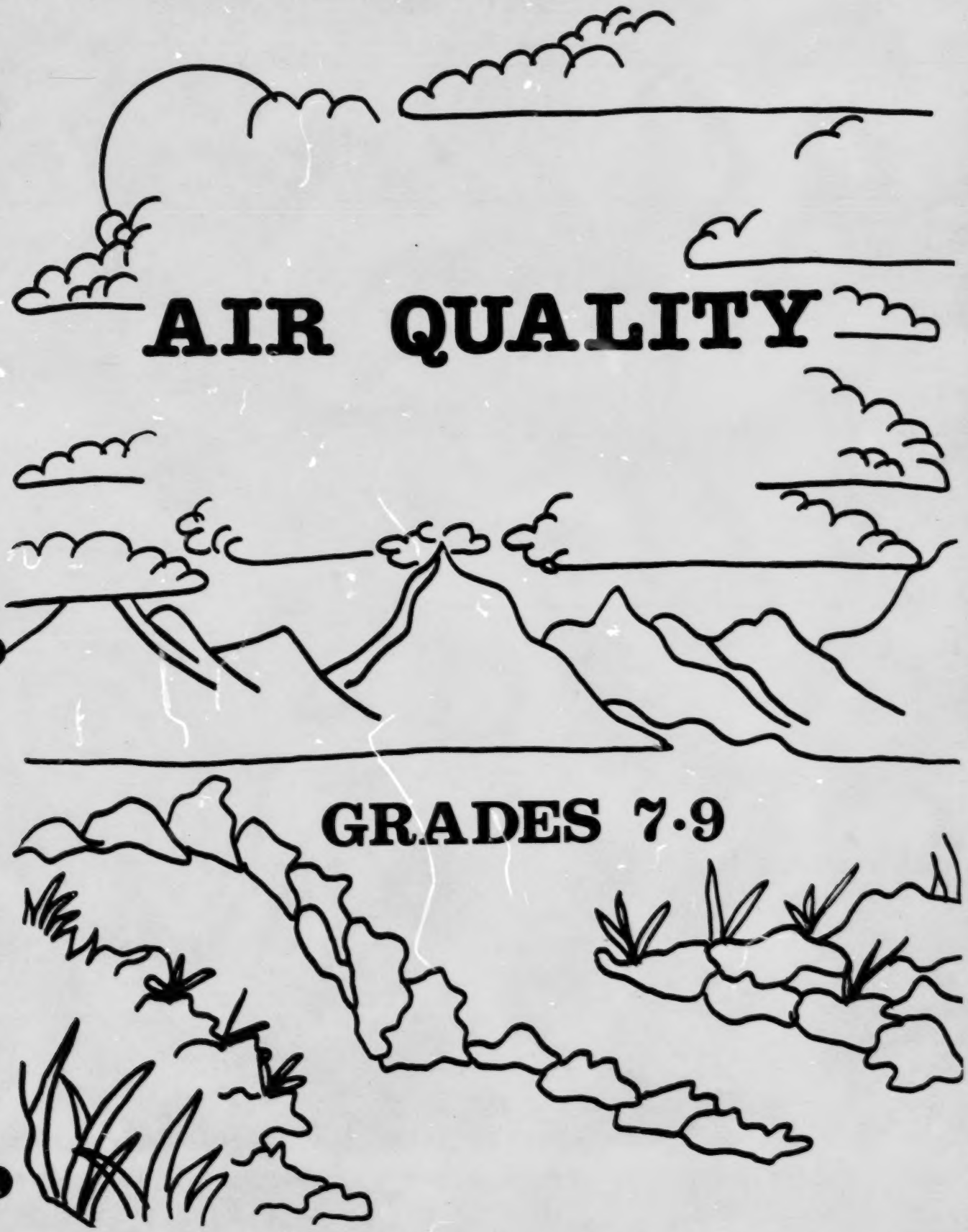
February 1980



AIR QUALITY

GRADES 7-9

STATE OF ALASKA

DEPT. OF ENVIRONMENTAL CONSERVATION

JAY S. HAMMOND, GOVERNOR

POUCH O – JUNEAU 99811

January 29, 1980

Dear Alaskan Educator:

The carbon monoxide and ice fog problems in Anchorage and Fairbanks present serious health threats to local residents. These problems are the result primarily of dramatic topographical and meterological conditions, combined with a dense population, a large enormous winter energy consumption, and the inefficient operation of automobiles in cold weather.

Some of the solutions, such as transportation planning and new technology, have a minimum impact upon people's day-to-day activities. But other solutions, such as use of mass transit and engine heaters, car pooling, keeping one's car properly tuned, driving less, or even giving up a vehicle, are solutions which often require additional expenses and even changes in lifestyle and attitudes. Behavior that causes environmental problems may often be hard to change due to personal attitudes and value systems.

These values and attitudes are developed at an early age, and we have designed this curriculum to help you provide future decision-makers with the knowledge of man's interrelationship with the environment and the ability to effect change. It is our hope that our children will be more knowledgeable, skilled, and motivated to demand cleaner air, to make responsible decisions concerning air quality, and to accept the resulting changes to their lives.

This curriculum is multi-disciplinary and can be approached from any of the following subject areas with little adaptation: health, science, social sciences, and government. The suggested activities include skills developed in art, English, drama, and library classes. It could be used very effectively when coordinated between classes taught in several subject areas.

We hope you find this material to be very useful in helping your students meet your own learning objectives, and at the same time learn about causes and solutions to one of Alaska's significant environmental problems.

Sincerely,

Ernst W. Mueller
Commissioner

AIR QUALITY

Introduction:

The five lessons which follow introduce the students to the ramifications of air pollution in Alaska.

Lesson one identifies and describes five air pollutants. They are carbon monoxide, particulate matter, hydrocarbons, sulphur oxides and nitrogen oxides.

Lesson two presents health hazards associated with each of the pollutants identified in lesson one. The students will write a story using the material presented in lessons one and two.

Lesson three identifies a serious Alaskan winter weather condition which intensifies existing air pollution dangers, a natural occurrence called "weather inversion". The students will create a radio play incorporating the newly presented information and what has been learned in the lessons before.

Lesson four focuses the students' attention solely on problems in Alaska. Because the greatest pollution problems in Alaska are transportation related, the information presented in lesson four emphasizes the role of the automobile.

Lesson five introduces a variety of possibilities which students and their families can do to limit the amount of air pollution in their community. This lesson ties in directly with solutions for the problems to which the students have been introduced.

Flexibility is a prime goal in the use of these lessons. The lessons may be taught in any order depending on the needs of the students and the availability of resources.

TEACHER RESOURCE LIST

The resources listed below can be found in the Alaska State Library system.

Adler, Irving, The Environment, 1976 (J 574.5 ADLE)

Borsoff, Norman, Don't Give Up, 1972 (J)

Bova, Benjamin, The Seeds of Tomorrow, 1977 (J 301.3 BOVA)

Brennan, Nicholas, Olaf's Incredible Machine, 1975 (J)

Dwiggins, Don, Spaceship Earth; A Space Look at our Troubled Planet, 1970 (J 628.5 DWIG)

Elliot, Sarah M., Our Dirty Land, 1976 (J 363.6 ELLI)

George, Jean Craighead, Hook A Fish, Catch A Mountain, 1975 (J)

George, Jean Craighead, Who Really Killed Cock Robin? An Ecological Mystery, 1971 (J)

Gregor, Arthur S., Man's Mark on the Land, 1974 (J 301.31 GREG)

Hoff, Sydney, Amy's Dinosaur, 1974 (J)

Hyde, Margaret Oldroyd, For Pollution Fighters Only, 1971 (J 628.5 HYDE)

McCoy, Joseph J., Shadows Over the Land, 1970 (J 628.5 MCCO)

Meyer, Louis A., The Clean Air and Peaceful Contentment Dirigible Airline, 1972 (J)

Peet, Bill, The Wump World, 1970 (J)

Pomerantz, Charlotte, The Day They Parachuted Cats on Borneo: A Drama of Ecology, 1971 (J 574.509 POME)

Field Trips and Community Information Sources

The following list of agencies, businesses, and places in Anchorage and Fairbanks have been collected for the purpose of planning field trips or "tapping" knowledgeable community resources. Activities planned to involve these resources may provide a way for the student to more easily understand how air pollution actually affects human life.

Anchorage

1) Air Pollution Control Agency
   825 L. Street
   Anchorage, AK 99501
   (This agency monitors air pollution in the Anchorage area. They can demonstrate how this is accomplished and provide detailed information on air quality in the city.)

2) Arctic Environmental Information and Data Center
   707 A. Street
   Anchorage, AK 99501
   (This is a research organization funded by the state of Alaska. It may be possible to arrange for a speaker on a topic of interest to your class.)

3) Alaska Department of Environmental Conservation
   338 Denali St., MacKay Building, Room 1206
   Anchorage, AK 99501
   (This office has a small staff. There is a possibility of arranging a speaker on the topic of pollution control)

4) Vern's Asphalt Maintenance
   Box 41319
   Anchorage, AK 99509
   (This business operates large road equipment which cleans dust and oil from the roads in Anchorage. Ambient particulate pollution is one of Anchorage's major air quality problems. This business can demonstrate how that problem can affect city life.)

5) Auto Shops
   contact through yellow pages
   (Auto shops may provide information and demonstration of how catalytic convertors and pollution control valves reduce polluting emissions from car engines.)

6) Asphalt Products Industries
contact through yellow pages
(All asphalt industries have been made to install pollution control devices. An explanation of how they control air pollution may be available from one of the local businesses.)

7) Tall Buildings
(High places such as tall buildings in Anchorage provide views of dust pollution and of weather inversions during the winter months.)

Fairbanks

1) Fairbanks North Star Borough
Environmental Services
P.O. Box 1267
Fairbanks, AK 99707
Contact person: Heather Stockard
(The Department of Environmental Services monitors and analyzes daily pollution information in its downtown location. Groups of students are welcome to view the facilities and will be given a guided tour by a person knowledgeable about air pollution. Speakers can also be arranged from this organization.)

2) Washington Alaska Montana Idaho (WAMI)
Medical Education Program, Univ. of AK, Fairbanks
479-7731
(This organization has previously done research about the health effects of air pollution. WAMI is a program within the University of Alaska and may be able to assist in special tours or speakers for older students.)

3) North Pole Refinery
P.O. Box 5028
North Pole, AK 99705
(The North Pole Refinery has previously provided tours for students. A field trip to this refinery will provide an opportunity to see how industry can control its pollution emissions through application of pollution control technology.

4) Municipal Utilities System
P.O. Box 60280
Fairbanks, Alaska 99707
(Students can witness a major pollution source and see how people have developed technology to control the pollution emissions given off in the production of electrical

energy. Other generating plants in the Fairbanks area are: University of Alaska and Fort Wainwright's power plants, and the Golden Valley Diesel Generating Plant.)

5) Alaska Department of Environmental Conservation
Northern Region Office, Box 1601, Fairbanks, AK 99707
phone: 452-1714
(Speakers are available. Personnel from this office can discuss problems general to Alaska as well as specific problems concerning the air quality in Fairbanks.)

6) During the winter months "ice fog" can be physically witnessed in several places in Fairbanks. It is particularly thick on the Richardson Highway near Fort Wainwright.

Tall buildings in Fairbanks may offer a unique vantage point to view the ice fog phenomena.

7) Fairbanks Environmental Center
218 Driveway
Fairbanks, AK 99701
(Information and speakers may be available from the organization.)

Lesson I — Five Air Pollutants

Objective: Students will be able to correctly complete a written response activity following a reading and discussion about five air pollutants.

Materials:
1 student reading material, Five Air Pollutants (pp. 10 - 12)
1 student response sheet: "Five Air Pollutants" (pg. 13)
film lists

Introduction: Students will most likely have formed a concept of air pollution from instructional experiences at school or through exposure from media sources. However, their knowledge base on this subject may be limited in the specific aspects of air pollution. The material which the students are to cover provides a brief overview of the topic and introduces five specific pollutants.

Of the five pollutants covered, carbon monoxide, hydrocarbons, and particulates constitute the major threat to Alaska's air quality. Sulfur oxides and nitrogen oxides, the other two major pollutants, are much less of a problem because the industries which produce these pollutants are not numerous in Alaska.

The major source of Alaskan air pollution comes from transportation-related activities. Originating directly from vehicle emissions, the gases and tiny ashes are produced in fuel combustion and then sent out the exhaust pipe.

The following film list represents the films available from the Alaska State Library on the subject of air pollution. The various films present different aspects of the problem. Each is capable of providing a basic overview and is therefore a valuable tool for introducing the subject of study.

40509 Air is for Breathing - 29 min.
Studies air pollution in the United States. Gives a reasoned analysis of what the main pollutants are and the principles that must guide a systematic and effective approach to pollution control. Illustrates the research that is improving our technical capability and some of the control measures being implemented. Concludes with the message that polluted air is everyone's business.

32674 Air Pollution - Take a Deep Deadly Breath - 54 min.
Analyzes proposed solutions to urban air pollution problems.

20291 Pollution Solution - 15 min.
Discusses how LANDSAT'S remote sensing capabilities can aid in resolving environmental quality problems. Shows that the satellite can locate and monitor strip-mining operations to facilitate land reclamation programs, help solve meteorological mysteries by tracking the path of airborne pollution and monitoring the courses of industrial wastes and garbage dumped into our lakes, rivers and coastal areas.

10395 Tom Lehrer Sings Pollution - 3 min.
Presents a musical satire on the effects of air and water pollution.

30415 The Vehicle Emission Control Story - 22 min.
Shows the research being done by automobile manufacturers in vehicle emission control to reduce air pollution. Emphasizes the importance of keeping a car well tuned, and points out vehicle inspection procedures.

42430 What Are We Doing To Our World - 52 min.
Points out ways of conserving our natural resources, Discusses air pollution, the population explosion, land usage, waste disposal and insecticides. Defines ecology and studies the ecological problems of the Everglades, Aswan Dam and Panama Canal. From the Twenty-First Century Series.

Additional Alaskan film sources are:

Pictures Inc.
811 W. 8th Ave.
Anchorage, Alaska 99501

Modern Talking Picture Service
Film Distribution Center for EPA films
1028 Industry Drive
Seattle, Washington 98188

"The Runaround" - 15 min.
An animated, often humorous film with a pass-the-buck plot concerning a man who wants to find the cause of his city's air pollution. The moving finger of responsibility finally points to him, and he can suddenly think of many reasons why he should not get involved.

Lesson I — Five Air Pollutants (cont.)

Vocabulary Preparation:

gas	emissions	carbon monoxide
nitrogen	particles	industrial
oxide	particulate	technological
sulfur	source	disease
	pollutant	respiratory system

Instructional Activities:

1. A) Begin the lesson by asking the class to create a definition of air pollution. This will provide an opportunity to survey the class on the information that they have already learned.

   B) Make a permanent record of the initial definition. This may later be used to let the class evaluate their own learning in terms of how new information has increased and deepened their understanding.

2. A) Preview the film you will show the class. Develop some questions to focus the student's attention and provide a basis for discussion when the film is over.

   B) Show the film.

3. A) Ask, "Can you name some specific air pollutants?"

   B) Distribute the reading material. Tell the students that in this material they will learn about the five major types of air pollution in Alaska.

   C) Have the students read the material in a way that best suits the group.

   D) Discuss what they have read to check on their comprehension.

   Ask, "Why is pollution more of a problem now than in the past? What health effects are caused by air pollution? In what areas of Alaska is the problem the greatest?"

   E) Ask, "What are the five major types of pollution in Alaska? What are the sources of each pollutant?"

4. Distribute the puzzle response sheet to reinforce the concepts. All answers are found in the students' reading.

Additional Activities:

1. Invite a guest speaker to class to introduce the topic. (doctor, health worker, pollution control monitor, researcher)

Five Air Pollutants

In this century, man has increased his productive capability a thousandfold. New industrial processes and technological inventions have improved our lives. But we are beginning to realize that the cost of this progress may also be heavy. Man has underestimated his ability to damage the environment and threatens not only the welfare of himself but the lives of his children as well.

One area of concern to scientists is air pollution. Most of what we know about the effects of air pollution on human health we have learned in the last decade. And only in the last five years have we begun to understand the way individual pollutants react with other chemicals to affect our health.

Scientists are convinced that air pollution is a very real contributing factor to the three major types of diseases that cause sickness and death - heart disease, lung disease, and cancer. Research has shown that air pollution will increase the rate of disease in those persons already afflicted, and earlier death is a real possibility.

The problem of air pollution is not limited to those persons who live in the cities or near the sources of pollution. Studies have shown that air pollution can actually be hazardous to people who live fifty, a hundred or even hundreds of miles away from the pollution source. This is because some common pollutants are carried by air currents, sometimes to other parts of the world.

In general, the air quality in Alaska is very good, as there are few large industrial sites or large population centers. The existing large industrial sources are isolated by distance and high mountain ranges. However, we can expect some impact on the environment as the population grows, more industries locate here, and the standard of living becomes higher.

Although Alaska contains fewer people and more area than any other state, these few people tend to stay in small "urban" areas, thereby concentrating the air pollution into limited air spaces. More than half of the state's population resides in the Anchorage area and more than three-fourths of the population resides near the four largest cities. The winter per capita energy consumption in Alaska is the highest in the world. Individuals here have a much greater impact on the environment than in other areas.

Although there are many kinds of air pollutants found in Alaska the following five are more common and affect large numbers of people:

CARBON MONOXIDE -

Carbon Monoxide is formed by incomplete burning of the carbon-containing materials: gasoline, wood, charcoal, paper, coal, etc. It is colorless and odorless. The largest source of carbon monoxide is automobile exhaust.

PARTICULATE MATTER -

"Particulate matter" includes a wide variety of compounds which may be further classified by size, chemicals and shape. Particle emissions are often classified as smoke, fumes, or dusts.

SMOKE is a visible product of incomplete burning. It consists mainly of small solid and liquid particles which are small enough to be suspended in air.

FUMES are small particles emitted by any source which burns carbon-containing materials, for example the processes used in the chemical, rubber, and metal industries. Fumes are gaseous when emitted but condense as they cool to form a liquid.

DUSTS are generally large solid particles which are typically a nuisance rather than a health hazard. They blow off fields, glacial sand deposits, unpaved roads, cement, asphalt and lumber industries.

HYDROCARBONS -

Hydrocarbons are unburned fuels in gaseous or vapor form. They are made up of chemically combined hydrogen and carbon compounds. These enter the atmosphere from many sources, an important one being the unburned or partially burned gasoline from motor vehicle and stationary engine exhausts. Hydrocarbons are also emitted during the refining, storing, and marketing of gasoline products.

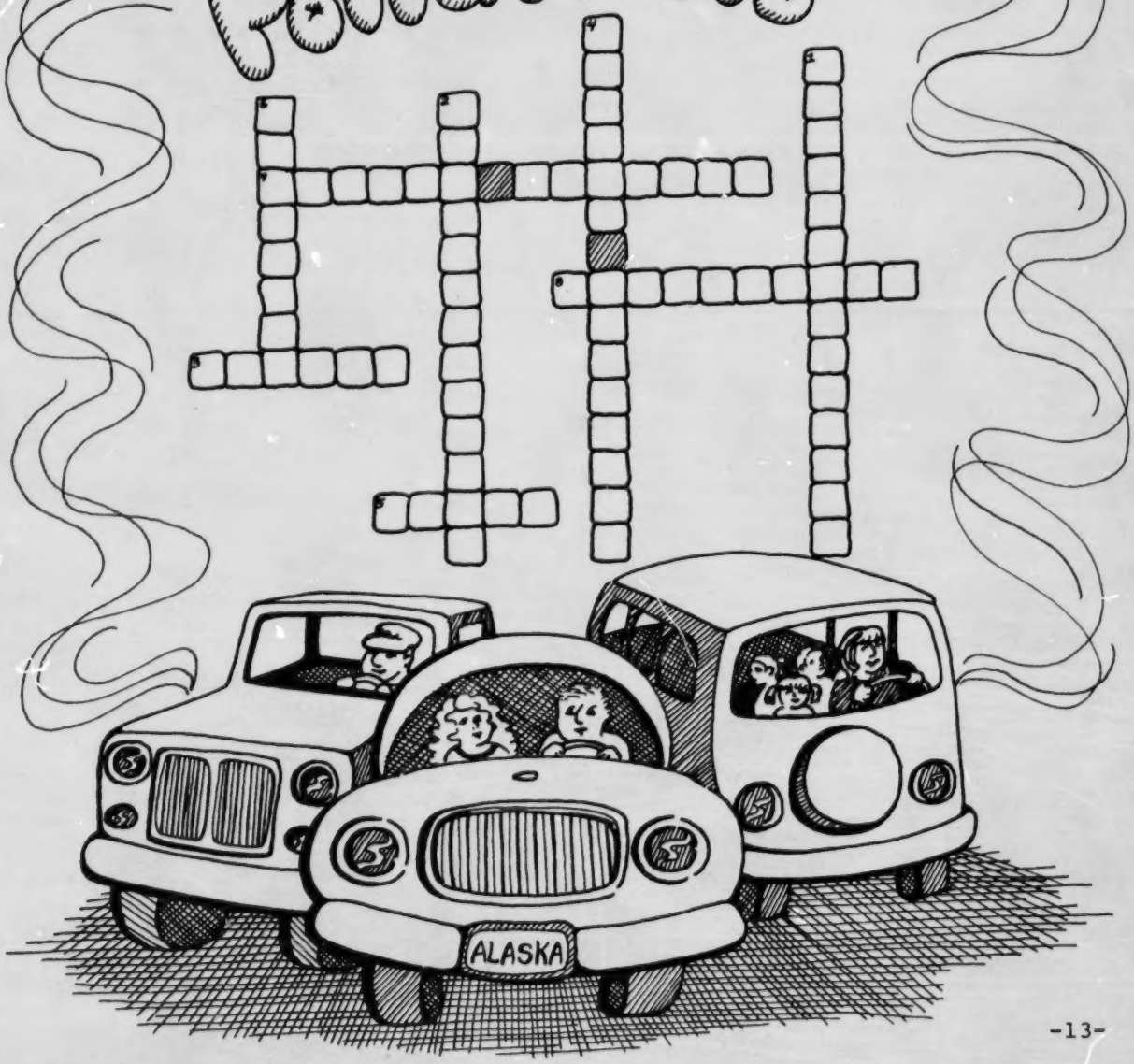
SULFUR OXIDES -

Sulfur oxides are gases that are formed by burning sulfur and sulfur-containing coal, gas, or fuel oil for industrial heating, home heating, wood pulping, refining, or for the production of electric power. Sulfur dioxide makes up about 95% of these gases and is a colorless gas with a suffocating odor. Sulfur oxides combine with moisture to produce sulfurous acid and the extremely corrosive sulfuric acid (hence, the "acid rain" phenomenon).

NITROGEN OXIDES -

Whenever anything is burned at a high temperature (above 650°C or 1,200°F) some of the abundant nitrogen in the air will react to, and combine with oxygen to form nitric oxide. The latter gas is harmless but can combine with more oxygen to form another gas - nitrogen dioxide. Furnace emissions and exhaust gases from engines contain oxides of nitrogen. Nitrogen dioxide is a suffocating, brownish-colored gas and a strong oxidizing agent, quick to react with water vapor to form nitric acid.

Five Air Pollutants



-13-

1. A major source of Alaskan air pollution comes from _____.
2. _____ _____ is a contributing factor to heart disease, lung disease and cancer.
3. The winter per capita _____ consumption in Alaska is highest in the world.
4. The largest source of _____ _____ is automobile exhaust.
5. _____ is a product of incomplete burning.
6. Hydrocarbons enter the atmosphere from automobile exhaust, and are also emitted during the refining, storing and marketing of _____ products.
7. _____ _____ is a colorless gas with a suffocating odor.
8. Furnace _____ and exhaust gases from engines contain oxides of nitrogen.

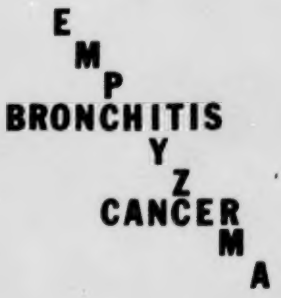
Five Air Pollutants

Answer Sheet

1. transportation
2. air pollution
3. energy
4. carbon monoxide
5. smoke
6. gasoline
7. sulfur dioxide
8. emissions

Lesson II — Health Effects of Air Pollution

Objective: Students will be able to write a story using information which they learned about specific pollutants and their associated health effects, to the teacher's satisfaction.



Materials:
- 1 student reading material: "Health Effects of Air Pollutants" (pp. 17 - 18)
- 1 review sheet of Lesson 1, Five Air Pollutants (pg. 20)
- 1 teacher resource material - Health Effects & Property Effects (pg. 19)

Introduction: The hazards to human health from air pollution have been well documented during the past two decades. After identifying five major types of air pollution in Lesson I, information is now presented about health hazards associated with each of the pollutants. Unless the pollutant is evident in massive amounts, illness and disease are not immediate results. The long term nature of pollution related health problems is an important aspect which obscures the dangers.

Listed for the teacher is an overview of the health and property effects of the five pollutants being discussed. More specific information is provided than in the general treatment included in the student reading material.

Vocabulary Preparation:

emission	sulfur	carbon	asthma
pollutant	sulfur oxide	carbon oxide	emphysema
gas	nitrogen	resistance	anemia
oxygen	nitrogen oxide	irritation	fatal
oxide	particulate	bronchitis	

Instructional Activities:

1. A) Begin the lesson with a review of the five pollutants discussed in Lesson I. Before passing out the review sheet entitled Five Air Pollutants ask, "Can you name the five air pollutants we have studied? Do you know where each of the five pollutants come from?"

   B) Distribute the review sheet and complete the review process with the students.

2. A) Inform the students that they will be expected to write a story which will take place in an environment of dangerously polluted air. The story will have to use some of the facts which they have learned. But before they begin they will first learn something of the health problems caused by breathing polluted air.

B) Ask, "Can you tell me about any disease or illness that the pollutants which we have studied will cause?"

C) Tell the students that the information they are about to receive will inform them of what can happen to people who breathe large quantities of polluted air. Distribute the material and have the group read in preparation for a short discussion.

D) Ask, "What parts of a person's body are most affected by pollution? What would happen to you if you breathed too much carbon monoxide? particulate matter?"

E) Direct the students to incorporate the new information about air pollution into their stories.

F) Those that need an idea may be helped by providing some sample title/starters.

The Killer Fog
How I Saved the World from Air Pollution
The Day the Sky Turned Brown
We Have to Move to the Moon
How the Space People Saved the World

Additional Activities: Students who work well in groups may be more stimulated if given an opportunity to produce a play on air pollution.

Health Effects of Air Pollutants

In recent years scientists have begun to look at human-caused pollution to find out where it comes from and what effects pollution has on human health. The following information will describe the health effects of the five pollutants you learned about in the last lesson.

CARBON MONOXIDE - is inhaled through the lungs and enters the blood stream by combining with red blood which normally carries oxygen to the cells. The result is that the amount of oxygen getting to the cells in the body is reduced in the presence of carbon monoxide, and this can have a serious effect on our health. Carbon monoxide also disturbs heart function by weakening the contractions of the heart which supply blood to the various parts of the body. The effect of this on a healthy person is to reduce his/her ability to perform exercise; but in a patient with heart disease, it can cause death. A person who has a heart attack in the presence of heavy carbon monoxide air pollution is more likely to die than if the attack had occurred in clean air. And carbon monoxide is also harmful to persons who have lung disease and anemia.

Carbon monoxide can also affect mental function at relatively small amounts. Visual perception and alertness can be affected.

PARTICULATE MATTER - does damage to the linings of the lungs and throat. Such injury may be temporary or permanent. It may be confined to the surface. However, by weakening resistance to infection, such pollutants may affect the entire body. Chemicals

carried into the lungs by particulates, for example, may cause cancer to develop on the lung lining, which then may spread throughout the body and prove fatal.

HYDROCARBONS - There have been no unhealthy effects directly associated with hydrocarbons. However, in sunlight this pollutant reacts with other pollutants in the air and creates a smog-like situation which causes respiratory irritation and stinging, watery eyes.

SULFUR OXIDES - Many scientists believe that a long range effect of breathing sulfates may be respiratory illnesses such as bronchitis, emphysema, and asthma. Studies show that children who breathe large amounts are more likely to develop respiratory illnesses when this is combined with large amounts of particulates.

NITROGEN OXIDES - This pollutant can affect lung tissue and lower the resistance of people to other types of illness. Hydrocarbons and nitrogen oxide combine in sunlight to cause eye, nose and throat irritation.

HEALTH EFFECTS & PROPERTY EFFECTS

SULFUR OXIDES -

Upper respiratory irritation at low concentrations; more difficult breathing at moderate concentrations, correlated with increased cardio-respiratory diseases; acute lung damage at high concentrations.

Corrosion and deterioration of steel, marble, copper, nickel, aluminum, and building materials; brittleness in paper, loss of strength of leather, deterioration of natural and synthetic fibers. "Burning" of sensitive crops.

PARTICULATES -

Correlated with increased bronchial and respiratory disease, especially in young and elderly.

Corrosion of metals and concrete; discoloring of surfaces; soiling of exposed materials; decreases visibility.

CARBON MONOXIDE -

Physiological stress in heart patients; impairment of psycho-motor functions; dizziness and headaches at lower concentrations; death at exposure to 1,000 parts-per-million for several hours.

Corrodes limestone and concrete structures.

NITROGEN OXIDES -

Eye, nose and throat irritation when combined with sunlight to form photo-chemical smog; lung damage.

Corrosion of metal surfaces; deterioration of rubber, fabrics and dyes.

HYDROCARBONS -

Hydrocarbons are unburned fuels in gaseous or vapor form. They are made up of chemically combined hydrogen and carbon compounds. These enter the atmosphere from many sources, an important one being the unburned or partially burned gasoline from motor vehicle and stationary engine exhausts. Hydrocarbons are also emitted during the refining, storing, and marketing of gasoline products.

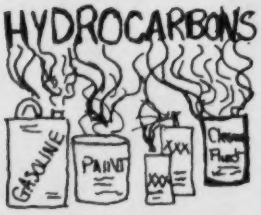
Note: Ice fog, familiar to Fairbanks and Anchorage residents, is not itself an air pollutant. But it can be the direct result of auto emissions and affect health and property. When the temperature is low enough, water vapor from combustion of hydrocarbon fuel or evaporation from an open pool of water forms ice crystals around particulate matter nuclei in the air. Motor vehicles provide a source of both the water vapor and the particles to serve as nuclei.

Ice fog directly affects health and property through accidents resulting from obscured visibility.

5 AIR POLLUTANTS

Carbon Monoxide is a colorless, odorless, tasteless gas commonly found in city air. The greatest source of this pollutant is the automobile.

Particulate Matter is the term for all types of particles in the air. These include soot, mists, sprays, dust, dirt as well as many chemicals and minerals produced by industries. Sources of particulates are both natural and human-caused. Particulates serve as the nuclei of ice fog.



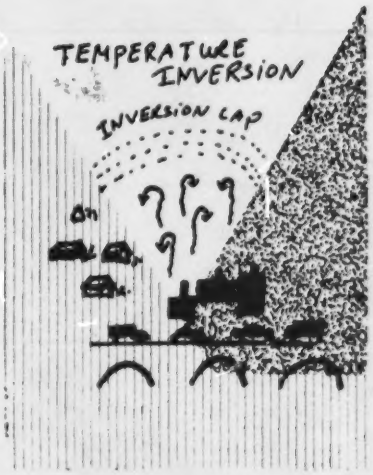
Hydrocarbons are mainly produced by motor vehicles. These also come from the evaporation of chemical solutions such as cleaning solvents, paint and gasoline fumes.

Sulfur Oxides are produced from coal and oil-burning power plants and factories.

Nitrogen Oxides are produced mainly by high temperature burning processes such as in power plants, auto and truck engines (temperature must be above 650°C, or 1200°F).

Lesson III — Weather Inversions

Objective: Students will be able to create a radio play incorporating newly presented information about weather inversions along with what has been learned concerning air pollution, to the satisfaction of the teacher.



Materials:
- 1 student reading material, Weather Inversions (pp. 23-27)
- 1 visual aid: "Temperature Inversion" (pg. 28) -- for overhead display or individual handouts.
- 1 student response sheet - "Weather Inversions" (pg. 29) -- optional.

Introduction: Natural weather conditions in Alaska intensify existing air pollution dangers by concentrating large amounts of air pollutants in confined urban areas. This occurs as a result of a mass of warm air at higher elevations moving over a cooler stream of air near the earth's surface. The warmer air acts as a "lid" thereby trapping the cooler air beneath it. Under normal weather conditions the pollutants in the air would be carried away by prevailing air currents but during an inversion the pollutants are trapped. As air pollutants continue to be produced the concentration becomes increasingly dangerous.

The subject of weather inversion is introduced to the students because of its importance to the overall Alaskan problem. Weather inversions are a winter phenomenon. It is also during the colder months that the largest amounts of pollutants are produced. The trapping of the air heavily laden with pollutants in urban areas creates a serious danger to human health.

Vocabulary Preparation:

inversion	dense	nausea
concentrate	stagnant	irritation
urban	visibility	disaster
horizontal	swamped	substances
vertical	nasal	environmental

Lesson III — Weather Inversions (con't)

Instructional Activities:

1. Ask, "Can anyone explain or give an example of a weather inversion?"

2. Inform the students that the information which they will read and discuss in this lesson will explain what a weather inversion is and how it affects the quality of Alaskan air.

3. Inform the students that they will be expected to write a radio (television) play about a weather inversion disaster. They must use the information which they will be reading about as well as the information concerning the five pollutants of which they have learned.

4. Distribute the reading material, Weather Inversions, and direct the class to read in a manner best suited to focus their attention.

5. Display the visual aid on an overhead projector or pass out individual copies. Use this to test the comprehension of the class and to reinforce their understanding of how an inversion is formed.

6. Ask, "Using this picture, can you explain how an inversion is formed?" Discuss the visual aid and check that the students understand that a warm upper layer of air, moving across a cooler mass of air, traps the cooler air and the pollutants which it might contain.

7. Ask, "Do you have enough information to write a play about air pollution disaster caused by a weather inversion?"

8. Remind the students that they must use facts about air pollution in writing their plays.

Additional Activities:

1. Have the students perform their plays for other classes.

2. Tape the plays to share with other classes or other schools.

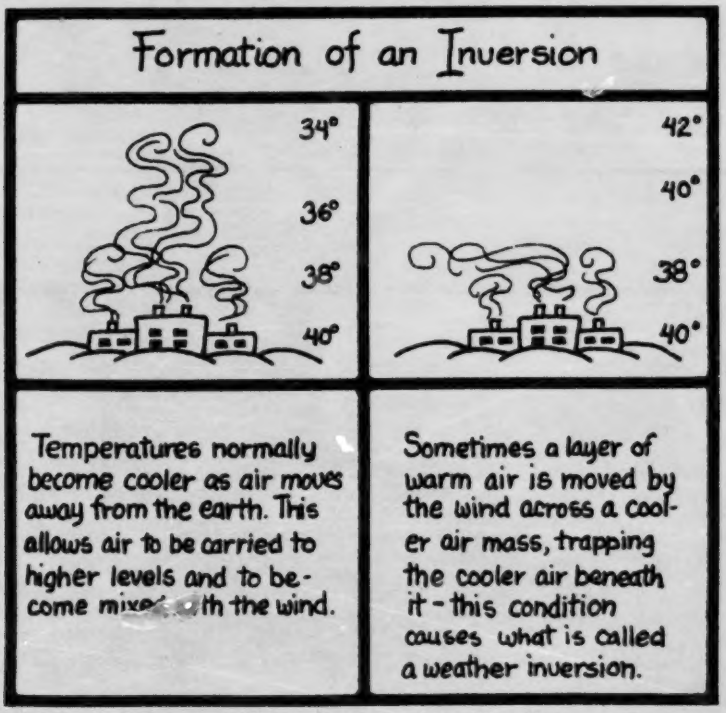
Weather Inversions

Although Alaska contains fewer people and more area than any other state, these few people tend to live together in small "urban" areas, thereby concentrating air pollutants into limited air spaces. More than half of the state's population lives in the Anchorage area and more than three-fourths of the population lives near the four largest cities. The average person's winter energy use in Alaska is the highest in the world. Individuals here have a much greater effect on the environment than in other states. Operation of automobiles during the winter months produces larger amounts of pollutants. The average person's home heating and household electrical use is also much higher than in most other states (see figure 1).

Comparison of Home Heating Energy Requirements

A house in Fairbanks needs 2.7 times more energy than a comparable house in Seattle to maintain a 68° F (20° C) inside temperature.

This high rate of pollution passed into the air is made even more dangerous during the winter months. A natural phenomenon known as a weather inversion can force the pollutants to lay in a thick mass close to the ground thereby increasing the amount of dangerous pollutants entering a person's lungs. Under normal conditions horizontal and vertical air movements (wind) blow air pollutants away. Inversions stop vertical air motions. Dense, cool surface air containing pollutants cannot rise through the less dense, warm air of an inversion. The inversion "puts a lid on" the lower air (see figure 2).


Formation of an Inversion
34°
36°
38°
40°
42°
40°
38°
40°
Temperatures normally become cooler as air moves away from the earth. This allows air to be carried to higher levels and to become mixed with the wind.
Sometimes a layer of warm air is moved by the wind across a cooler air mass, trapping the cooler air beneath it - this condition causes what is called a weather inversion.

The winter inversions which occur in Alaska are among the strongest found anywhere in the world. The long winter nights prolong these inversion periods and a strong potential for air pollution incidence may last for several weeks. In Fairbanks, for example,

very strong inversions combined with low wind speeds create high levels of air pollution for long periods of time. The air movement or ventilation rate during these times is only one-half to one-fourth as much as during the worst conditions recorded in the "lower 48" states, causing two to four times greater potential for air pollution.

Weather inversions happen several times a year in cities throughout Alaska. So far there has been no recorded evidence of severe health effects caused by these inversions. Other places on the earth have not been so fortunate. On October 26, 1948, citizens of Donora, Pennsylvania, awoke to a strange dark morning. The various industries and businesses of the town were sending their usual pollutants into the air. On any ordinary day, warm, light air rising from the ground surface carried such pollutants into the cooler atmosphere above. Here they were carried away by prevailing winds. However, on this particular day, a blanket of warm air had formed above the cooler air mass covering the town. During the day, warm surface air and vapors produced by industries steadily cooled while rising. When this air reached the upper limits of the cold air mass, it was no longer lighter than the warmer air mass above. Unable to rise further, the polluted air was trapped between the upper and lower air masses. Gradual cooling of the stagnant air mass resulted in a steady rain of filth on the town. Within 48 hours, visibility was greatly reduced. Donora medical people were swamped with people suffering from a range of illnesses: stinging eyes, throat irritation, nausea, breathing difficulties, nasal congestion, and coughing. During the four long days that the deadly cover hung over Donora,

almost 50% of the 12,300 citizens suffered illness. Before a heavy rain eventually cleared the air, death claimed 20 people and numerous animals such as cats, dogs and birds.

Temperature inversions like that in Donora have happened for millions of years. They are a natural weather phenomenon. Inversions are most often related to weather conditions and land shape (topography). The danger of an inversion is that it traps the air that we pollute and concentrates the harmful substances. Donora is only one example of the problem that faces us. There have been other times in other places on our planet where weather inversions and human-made pollution have caused people to become sick and contributed to an early death.

The worst recorded air pollution disaster took place in London, England, during December, 1952. A temperature inversion over the city produced a five-day nightmare. Steady contributions of soot and smoke from the coal-burning city reduced visibility to less than a yard within three days. Before a passing cold air mass cleared the terrible smog, 4,000 people died as a direct result of pollution. During the following two months, another 8,000 people died from illnesses directly caused by this killer smog. Since 1953, New York City has suffered four times from critical pollution during temperature inversions.

Nothing this serious has happened yet in Alaska. However, the conditions are here that make a serious problem possible. Fairbanks is a small city with a big-city air pollution problem. Winter levels of carbon monoxide in the air are comparable to those in New York

and Los Angeles. And while Anchorage's carbon monoxide problems are not yet as well defined, it is quite possible that the city has as much of a problem as Fairbanks.

TEMPERATURE INVERSION

Weather Inversions

Answer the following questions in complete sentences.

1. In your own words, tell what a weather inversion is and how it is formed.

2. What makes a weather inversion dangerous when it happens near a modern city?

3. With the information that you learned in the last two lessons what do you think people can do so that weather inversions will not create dangerous health hazards?

Lesson IV — Air Pollution in Anchorage and Fairbanks

Objective: Students will make posters to show how to reduce air pollution following a reading assignment on specific facts concerning pollution in Anchorage and Fairbanks, to the satisfaction of the teacher.

Materials:
- 1 student reading material, Danger in the Alaskan Air (pp. 34-36)
- 1 student response sheet - "Danger in the Alaskan Air" (pg. 37) -- optional
- poster making materials
  - large paper (railroad board, butcher paper), paints crayons
  - masking tape

Introduction: This lesson focuses the students' attention solely on problems in Alaska. Because the greatest pollution problems in Alaska are transportation related, the information presented here emphasizes the role of automobiles.

The student material presents a general overview of the problem concerning the automobile's role as a major air polluter. It emphasizes how cold weather helps to create a more serious problem. The article concludes by offering suggestions on how proper attention to one's automobile will help reduce pollution emissions.

The following information will provide you with more detailed background information on the problems of cold weather automobile emissions. This pollution source coupled with a weather inversion has the potential of creating a serious threat to human health and life.

"During the past three years, it has become increasingly apparent that motor vehicle cold weather operation poses different air pollution control problems than those found in warmer climates. However, only now is there quantitative data on which to begin evaluation of cold weather air quality conditions.

Lesson IV — Air Pollution in Anchorage and Fairbanks (con't)

"Cold weather substantially increases motor vehicle carbon monoxide emissions because of three basic reasons: Maintenance of vehicles is more difficult, vehicle engines tend to operate at richer air-to-fuel ratios (especially during startup), and engines take much longer to reach a temperature where the engine will operate properly. Consequently carbon monoxide emissions during the engine warm-up period are typically high, and may account for as much as 92% of the total vehicle trip emissions.

"The present methods used in estimating motor vehicle pollutants do not realistically account for vehicle cold start emissions. The methods are based on the "average carbon monoxide emitted per vehicle mile travelled" throughout a driving cycle. This technique will provide misleading results since a large percentage of the total pollutant output may be produced before the car is driven. Averaging the cold start emissions over the entire driving cycle will also produce erroneous conclusions if most of the total pollutants are emitted in the first half-mile of driving. These conditions are typical of cold-weather driving." (A Review of Carbon Monoxide Emissions from Motor Vehicles During Cold Temperature Operation, Alaska Department of Environmental Conservation, March 1979)

Vocabulary Preparation:

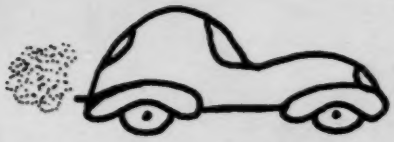
mobility	concentration	exhaust
hazard	varies	vehicle
combustion	increases	researcher
anemia	carbon monoxide	emission
devices		

Instructional Activities:

1. Before passing out the reading material, review what the students have learned about the relationship between automobiles and pollution. The following table may be drawn on the chalkboard or an overhead projector. This will provide a way of collecting the information, organizing it, and presenting it visually back to the students.

(review)

The Automobile

Pollutants	Health Hazards
carbon monoxide	dizziness, emphysema
hydrocarbons	headaches, bronchitis
particulates	fatigue, eye irritation
photochemical smog	heart disease
	asthma
	anemia
	lung cancer
	respiratory disease

Lesson IV — Air Pollution in Anchorage and Fairbanks (con't)

2. Ask, "What three pollutants did we study about in Lessons I and II that are produced by automobiles?"

3. Ask, "What are the health effects which we studied about in Lesson II that were caused by carbon monoxide? hydrocarbons? particulates?"

(new activity)

4. The pollutants produced by cars and related transportation activities are Alaska's major air pollution problem. Inform the students that the reading material which they are to read will give them information on how car pollution can be reduced.

5. Inform the students that they will be expected to make a poster of how car pollution can be reduced following the reading.

6. Distribute the reading material, Danger in Alaskan Air. Have the students read in a way that best focuses the group's attention.

7. After the reading ask, "What is the danger in Alaskan air? What causes this dangerous pollutant to be in the air?"

8. Ask, "What are the four ways that were mentioned to control car emissions?"

(student response)

9. Direct the students to produce a poster, using the new information and what they have learned about pollution in the previous lessons.

10. If possible, use the completed posters to make a bulletin board display in the classroom and/or somewhere else in the school building.

Additional Activities:

1. Invite a guest speaker to class to explain how an engine works and/or how pollution devices help reduce air pollution.

2. A pamphlet entitled Clean Air And Your Car, available from the Alaska Department of Environmental Conservation in Anchorage, Fairbanks, or Juneau, will provide a more detailed coverage of car emission control.

Danger In The Alaskan Air

Automobiles are Alaska's number one pollution problem. They create serious health hazards through the particulate matter and dangerous gases which they cause to enter the air. The same car that provides us with transportation and gives us pleasure of mobility shortens our lives and endangers our health.

The automobile produces carbon monoxide as a by-product of engine combustion. Carbon monoxide is an odorless, colorless gas given off when fuel is burned. It is extremely dangerous because of its poisonous properties. Carbon monoxide is the most common pollutant in city air.

Carbon monoxide is inhaled through the lungs and enters the blood stream by combining with red blood which normally carries oxygen to the cells. The result is that the amount of oxygen getting to the cells in the body is reduced in the presence of carbon monoxide and this can have a serious effect on our health. Carbon monoxide also disturbs heart function by weakening the contractions of the heart which supply blood to the various parts of the body. The effect of this on a healthy person is to reduce his/her ability to perform exercise; but in a patient with heart disease, it can cause death. A person who has a heart attack in the presence of heavy carbon monoxide air pollution is more likely to die than if the attack had occurred in clean air. And carbon monoxide is also harmful to persons who have lung disease and anemia.

The concentration of pollutants varies according to weather conditions. The cold months increase the dangers to human

health from air pollution by increasing the concentration of pollutants. During the winter, the air in Alaska's Anchorage and Fairbanks areas contains more carbon monoxide than has been determined as healthy.

Almost all the carbon monoxide is produced by automobiles. Even though car exhaust controls have been required for several years, carbon monoxide levels have not shown a great change, partly because much of the carbon monoxide is given off during the first four to ten minutes in which a car is warming up.

Since 1974, the state of Alaska has placed increasing emphasis on the importance of automobile pollution during the first 4-8 minutes of operation in cold weather. The pollutants given off during this time are known as the "cold start emissions", and can account for the vast majority of all carbon monoxide emitted for the whole vehicle trip. Carbon monoxide emissions during the engine warm-up period may account for as much as 92% of the total vehicle trip emissions.

It has been found that there are ways to reduce carbon monoxide during the cold start operating phase. Researchers have found that cars equipped with exhaust controls on the engines, which are required by several states, are effective in reducing pollution. Some cars, such as the Honda CVCC and those using diesel fuel, have better designed engines which automatically give off fewer pollutants. Engine preheat devices are also helpful in reducing engine cold start pollutants, depending on how long they are used. The most effective of these are electrical

plug-ins and automatic start devices. Another method of controlling cold start pollution is through regular engine tune-ups and maintenance. This is probably at least as important as having a special exhaust control placed on the car engine.

Danger in the Alaskan Air

Answer the following questions in complete sentences.

1. What types of pollution do automobiles produce?

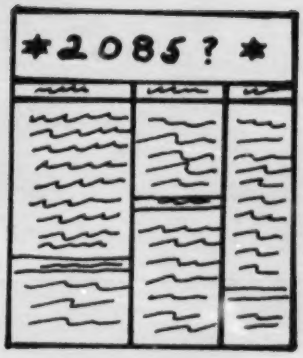
2. In what ways do carbon monoxide gases affect our bodies?

3. What are "cold start emissions"?

4. How can cold start emissions be reduced?

Lesson V Personal Involvement

Objective: Students will be able to produce innovative solutions to pollution problems through the writing of newspaper articles from the year 2085 telling how people in Alaska were able to solve air pollution problems, to the satisfaction of the teacher.



Materials: writing paper
pencils
1 teacher background reading material, Proposed Solutions (pp. 40-42)
1 Pollution Chart (pg. 43)

Introduction: The students have been presented with material and activities to teach them about the sources and effects of air pollution. They should now have a sufficient base of information from which to write and choose ways of how to eliminate various pollutants. It is not as important that the students are able to create comprehensive solutions as it is that they constructively use the information which they have been studying and begin to think about the need for solutions.

This assignment can be varied according to the experience, abilities and needs of the group. Because the students will have a limited understanding of the complexities of the problems involved, they are asked in this lesson to approach solutions through a mode of thought important to them at this age - personal fantasy. It is the intent of this lesson to provide an opportunity for the students to think about solutions to real problems in a manner that will involve the students in making some inferences about the material they have studied.

If the sophistication and maturity of the group is more developed, the lesson can be altered to incorporate real problem solving. Letters to political figures may be worthwhile in which the students are suggesting action or requesting more detailed information. More involved research projects into mass transportation or alternative energy sources might be initiated.

Lesson V — Personal Involvement

The reading material which follows this lesson will provide you with the proposals for air pollutant reduction which have been made by the Alaska Department of Environmental Conservation. These proposals have been published in a document entitled State of Alaska Proposed Revisions To Air Quality Control Plan, Volume I, December 1, 1977.

Because the automobile and transportation related activity has been identified as Alaska's major air pollution problem, the proposals are concerned with the control of vehicle emissions. During the student review and in preparation for the assignment, the students should be helped to understand this is a major aspect of Alaska's pollution problem.

Instructional Activities:

1. Use the chart to organize the information which the students have studied and to make a visual display which the students can refer to during the assignment. Depending on the materials and equipment available this chart can be reproduced on an overhead projector, on large chart paper, or a chalkboard.

2. In reproducing the chart, fill in the information under problems, reasons and sources. Leave the column for solutions blank.

3. Place the chart before the class and review the past information.

4. Ask, "What solutions can you think of to reduce the amount of carbon dioxide? particulates? hydrocarbons? sulfur dioxides? nitrogen oxides?"

5. Ask, "What do you think the future will be like if the pollution problem continues to grow? What would the world be like if there was no pollution?"

6. Direct the students to write a newspaper article as if they were in the year 2084 and reporting on how the people in Alaska were able to solve their air pollution problems.

Additional Activities:

Develop a simulated situation in which a group of city people have been asked to solve the city's air pollution problems. Each of the people should represent a different point of view (a pollution control officer, a car distributor, the mayor who is supported by big businesses, a state congressperson elected by liberal independents, the Audubon Society president).

The information below was taken from Alaska's Air Quality Control Plan produced by the Alaska Dept. of Environmental Conservation.

Automobile Cold Start Emissions

A unique automobile pollution emissions problem, the "cold start phenomenon", is brought on with cold weather. During the warm-up period of a cold engine just started, an automobile emits much more carbon monoxide and hydrocarbon gases than during the remainder of a normal vehicle's trip. This occurrence, coupled with the severe pollution potential caused by extreme temperature inversions, leads to high concentrations of pollutants in the air.

The means for controlling cold start emissions must be developed. This may be the most important way to reduce winter carbon monoxide emissions. A study in Fairbanks estimated that 76% of the carbon monoxide in the downtown area could be linked to cold starts. Poor combustion (and thus high CO levels) occurs near the cylinder wall in an engine, resulting in high CO emissions. This is especially true for cold engines. The pollutant emissions caused by cold starts are roughly proportional to the size of the engine, since a larger engine requires more warm-up energy. Therefore, maintaining the engine's high operating temperature or reducing the average engine size may reduce cold start emissions.

Cold start emissions form a large part of the total carbon monoxide emitted by motor vehicles not only in Alaska but also in many of the other northern states in the U.S. For this reason, high CO levels from cold start emissions are not just an Alaskan problem, but also a national one. To reduce pollutants from cold start engines, the latest scientific knowledge must be applied. The technology exists now to accomplish this, but a solution needs to be found that is cheap and easy to use. One device, not now available to the average car owner, results in a decrease both in air pollution and in energy consumption. This system stores in a salt solution the heat given off from the engine. The stored energy is then used to preheat the engine before startup. A Fairbanks engineer designed a model in the early 1970's. This device also makes overnight parking and restarting of a vehicle during cold weather possible when electrical power is not available.

Vehicle Emission Inspection

If vehicles are periodically inspected and properly maintained, they will produce less pollution. A program of periodic auto inspection to test their emissions, with adjustments made accordingly, is one means of reducing air pollution from motor vehicles. The Fairbanks North Star Borough and the Atlantic Richfield Company have conducted vehicle emission surveys in Alaska. Data from these and other studies have shown that automobile inspection and maintenance might reduce vehicle emission by 10-20%.

Fairbanks has had a voluntary program for vehicle emission inspection since 1973. In 1979, certain service stations will be inspecting vehicles free of charge from October 1 to November 30. The program is run in conjunction with the Borough and the Alaska Department of Environmental Conservation. Fifty cars are expected to be checked per day, with a total of 2,000 cars anticipated for the two months. The winter inspection will continue over the next few years during which time its effectiveness in reducing air pollution will be evaluated.

The Municipality of Anchorage plans to begin a 9 month vehicle emission inspection program in the winter of 1979. Total number of cars checked is expected to be 7,500. The Municipality plans to use the program for public education on air pollution in addition to keeping vehicles properly maintained.

Transportation Planning

Developing sound, workable transportation plans and putting them into effect is the best, long-range means of controlling transportation-related air pollution. Several strategies may be employed, including:

1) Parking management, which is being considered in Fairbanks to reduce traffic congestion and cold start emissions. The Fairbanks North Star Borough has recently released a draft plan for the Downtown Fairbanks area. A similar effort is being considered in Anchorage. This type of management would be the responsibility of the borough or the unified local government.

2) More efficient transportation, through efforts such as car-pooling incentive programs and staggered work hours. The state has developed a car-pool and staggered work hour program for state employees in Fairbanks. Other agencies and private firms are being encouraged to follow suit and take steps toward abating the problems.

3) Transit systems, which can reduce traffic and pollutant emissions. The Fairbanks North Star Borough currently has a transit system, and expansion into additional routes is being planned. The Anchorage Municipality is experiencing preliminary success with its "People-Mover" transit system. As the number of riders increases, more routes will be added. Transit systems are not often economically self-supporting, but any increase in ridership will have a corresponding decrease in vehicle use.

4) Sound development of transportation systems. Both Anchorage and Fairbanks have started limited transit systems as described above. Preliminary results from both systems show that demand for the service exceeds the supply during several hours of the day and both cities are considering expanding the much-needed service. The construction of new highways, railways, transit systems, or other transportation facilities needs to be consistent with a long-term transportation goal for achieving convenient, efficient, and economical transportation in and around cities.

Emergency Avoidance

The Fairbanks North Star Borough has developed an emergency avoidance plan to reduce traffic congestion and public exposure to carbon monoxide in case excessive CO concentrations occur. The Fairbanks North Star School District has a similar plan in effect whereby the schools will not open and the school buses will not operate during periods of high pollutant concentration or severe ice fog. The state also has a plan to reduce congestion by reassigning most of the 300+ state employees in downtown Fairbanks to alternate work locations where pollutant concentrations are potentially less harmful. The Cook Inlet District has an emergency episode program which consists of public education efforts, such as spot announcements on radio, to reduce the problem in the central business district. It is a voluntary program and does not make use of any extraordinary measures.

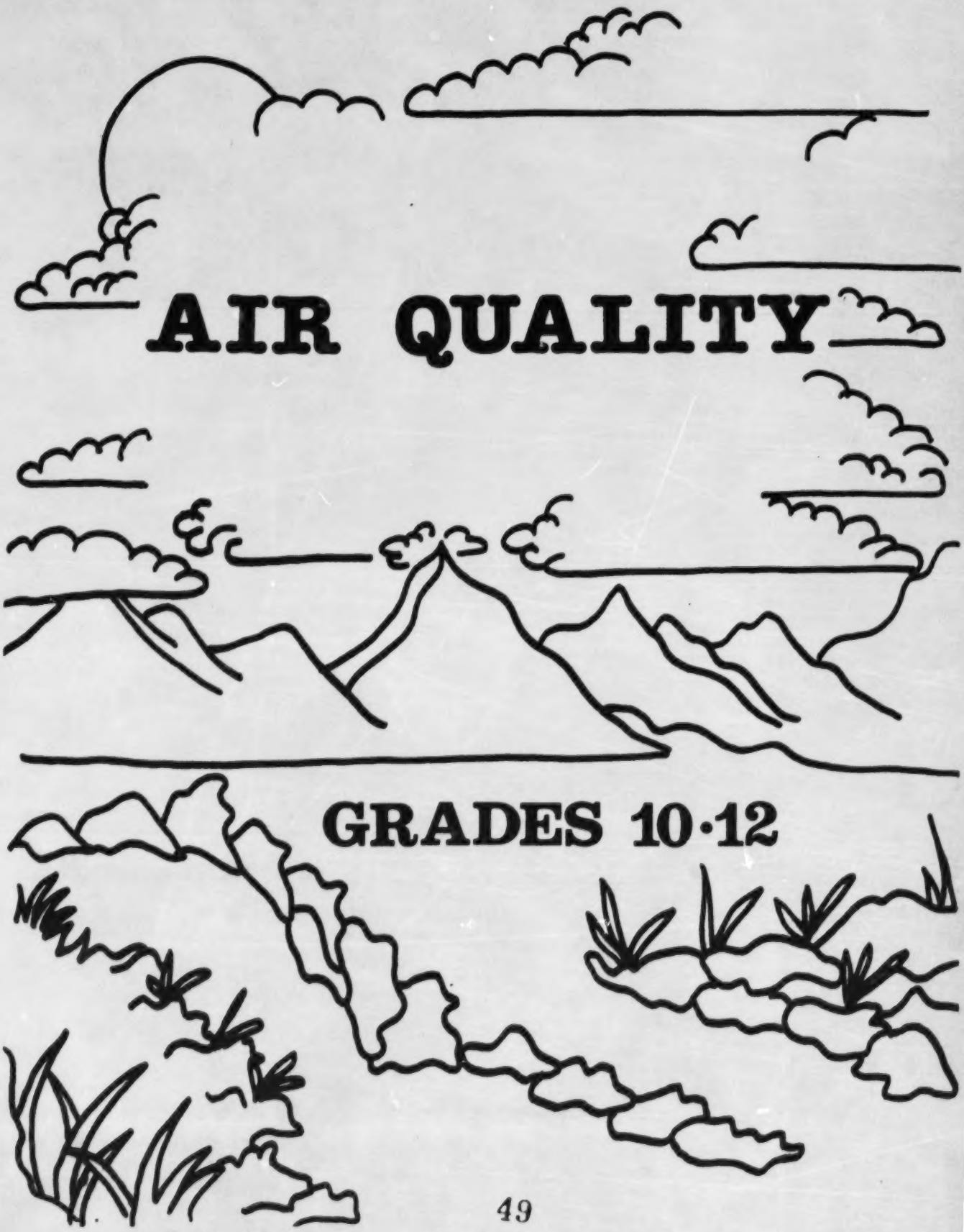
Idling Prohibition

During the winter, 3% of the 64,000 parking spaces in Fairbanks are occupied at any time by idling vehicles, accoring to the Parking Management Study conducted for the Fairbanks North Star Borough. This constitutes a significant source of carbon monoxide since an idling engine is not running at its most efficient speed, but no firm estimates of idling's contribution to the total concentration of CO are available.

Idling cars tend to occur in groups (such as shopping areas and movie theatres) and can therefore create very polluted air localized around them.

Pollution Chart

Problems	Reasons	Sources	Solutions
dizziness, asthma, headaches, anemia, heart disease.	carbon monoxide	automobiles	
irritates eyes, nose, throat; damages lungs; kills plants; heart disease.	sulfur oxides	industry - coal & oil, burning power plants	
irritates eyes, nose, throat; affects lungs.	nitrogen oxides	industry	
cancer; respiratory problems.	hydrocarbons	automobiles	
carry poisonous gas to lungs.	particulates	automobiles, industry	
irritates eyes, nose, & throat, affects breathing, damages plants.	photochemical smog	gases & particles in air changed by the sun	



AIR QUALITY

GRADES 10-12

STATE OF ALASKA

DEPT. OF ENVIRONMENTAL CONSERVATION

JAY S. HAMMOND, GOVERNOR

POUCH O — JUNEAU 99811

January 29, 1980

Dear Alaskan Educator:

The carbon monoxide and ice fog problems in Anchorage and Fairbanks present serious health threats to local residents. These problems are the result primarily of dramatic topographical and meterological conditions, combined with a dense population, a large enormous winter energy consumption, and the inefficient operation of automobiles in cold weather.

Some of the solutions, such as transportation planning and new technology, have a minimum impact upon people's day-to-day activities. But other solutions, such as use of mass transit and engine heaters, car pooling, keeping one's car properly tuned, driving less, or even giving up a vehicle, are solutions which often require additional expenses and even changes in lifestyle and attitudes. Behavior that causes environmental problems may often be hard to change due to personal attitudes and value systems.

These values and attitudes are developed at an early age, and we have designed this curriculum to help you provide future decision-makers with the knowledge of man's interrelationship with the environment and the ability to effect change. It is our hope that our children will be more knowledgeable, skilled, and motivated to demand cleaner air, to make responsible decisions concerning air quality, and to accept the resulting changes to their lives.

This curriculum is multi-disciplinary and can be approached from any of the following subject areas with little adaptation: health, science, social sciences, and government. The suggested activities include skills developed in art, English, drama, and library classes. It could be used very effectively when coordinated between classes taught in several subject areas.

We hope you find this material to be very useful in helping your students meet your own learning objectives, and at the same time learn about causes and solutions to one of Alaska's significant environmental problems.

Sincerely,

Ernst W. Mueller
Commissioner

AIR QUALITY

Introduction:

The next five lessons can be used by the student to develop a concise definition of air pollution in which health problems are identified as a major concern.

Lesson one is an overview of air pollution problems and will provide a starting point common to all students as well as provide a focus for future information.

Lesson two narrows the focus on pollution to five specific pollutants and their associated health hazards. The five major types of air pollution are: carbon monoxide, particulate matter, hydrocarbons, sulphur oxides and nitrogen oxides.

Lesson three introduces weather inversion and informs the student of how weather factors can intensify concentrations of pollutants which increases the chances of illness.

Lesson four provides factual information concerning air quality in Anchorage and Fairbanks. Identification of the major pollution source during cold weather months follows with a description of the automobile's role as polluter.

Lesson five provides an opportunity for the student to become involved in finding solutions to meet the problems exposed in the past activities. A research project and oral presentation are the student activities in this lesson.

Flexibility is a prime goal in the use of these lessons. The lessons may be taught in any order depending on the needs of the students and the availability of resources.

TEACHER RESOURCE LIST

The resources listed below can be found in the Alaska State Library system.

Berthovex, P. Mac, Strategy of Pollution Control, 1977 (TD 170 .B 493)

McCombs, Lawrence W., What's Ecology?, 1973 (QH 541 .M3)

Gildea, Ray Y., Arsenic and Old Lead, 1975 (TD 175 .G54)

Gofman, John William, Poisoned Power; The Case Against Nuclear Power Plants, 1971 (TK 9152 .G57)

Hynes, H.B., The Ecology of Running Waters, 1970 (QH 96 .H8 1970)

Millard, Reed, Clean Air - Clean Water For Tomorrows World, 1971 (HC 79 .E5 M5)

Simon, Seymour, Science Projects in Ecology, 1972 (QH 541 .14 .S55)

Smith, Stephen M., Energy-Environment Mini-Unit Guide, 1975 (TJ 163.23 .E53)

Taub, Harold J., Keeping Healthy In a Polluted World, 1974 (RB 152 .T38 1974)

Field Trips and Community Information Sources

The following list of agencies, businesses, and places in Anchorage and Fairbanks have been collected for the purpose of planning field trips or "tapping" knowledgeable community resources. Activities planned to involve these resources may provide a way for the student to more easily understand how air pollution actually affects human life.

Anchorage

1) Air Pollution Control Agency
   825 L. Street
   Anchorage, AK 99501
   (This agency monitors air pollution in the Anchorage area. They can demonstrate how this is accomplished and provide detailed information on air quality in the city.)

2) Arctic Environmental Information and Data Center
   707 A. Street
   Anchorage, AK 99501
   (This is a research organization funded by the state of Alaska. It may be possible to arrange for a speaker on a topic of interest to your class.)

3) Alaska Department of Environmental Conservation
   338 Denali St., MacKay Building, Room 1206
   Anchorage, AK 99501
   (This office has a small staff. There is a possibility of arranging a speaker on the topic of pollution control)

4) Vern's Asphalt Maintenance
   Box 41319
   Anchorage, AK 99509
   (This business operates large road equipment which cleans dust and oil from the roads in Anchorage. Ambient particulate pollution is one of Anchorage's major air quality problems. This business can demonstrate how that problem can affect city life.)

5) Auto Shops
   contact through yellow pages
   (Auto shops may provide information and a demonstration of how catalytic convertors and pollution control valves reduce polluting emissions from car engines.)

6) Asphalt Products Industries
contact through yellow pages
(All asphalt industries have been made to install pollution control devices. An explanation of how they control air pollution may be available from one of the local businesses.)

7) Tall Buildings
(High places such as tall buildings in Anchorage provide views of dust pollution and of weather inversions during the winter months.)

Fairbanks

1) Fairbanks North Star Borough
Environmental Services
P.O. Box 1267
Fairbanks, AK 99707
Contact person: Heather Stockard
(The Department of Environmental Services monitors and analyzes daily pollution information in its downtown location. Groups of students are welcome to view the facilities and will be given a guided tour by a person knowledgeable about air pollution. Speakers can also be arranged from this organization.)

2) Washington Alaska Montana Idaho (WAMI)
Medical Education Program, Univ. of AK, Fairbanks
479-7731
(This organization has previously done research about the health effects of air pollution. WAMI is a program within the University of Alaska and may be able to assist in special tours or speakers for older students.)

3) North Pole Refinery
P.O. Box 5028
North Pole, AK 99705
(The North Pole Refinery has previously provided tours for students. A field trip to this refinery will provide an opportunity to see how industry can control its pollution emissions through application of pollution control technology.

4) Municipal Utilities System
P.O. Box 60280
Fairbanks, Alaska 99707
(Students can witness a major pollution source and see how people have developed technology to control the pollution emissions given off in the production of electrical

energy. Other generating plants in the Fairbanks area are: University of Alaska and Fort Wainwright's power plants, and the Golden Valley Diesel Generating Plant.)

5) Alaska Department of Environmental Conservation
Northern Region Office, Box 1601, Fairbanks, AK 99707
phone: 452-1714
(Speakers are available. Personnel from this office can discuss problems general to Alaska as well as specific problems concerning the air quality in Fairbanks.)

6) During the winter months "ice fog" can be physically witnessed in several places in Fairbanks. It is particularly thick on the Richardson Highway near Fort Wainwright.

Tall buildings in Fairbanks may offer a unique vantage point to view the ice fog phenomena.

7) Fairbanks Environmental Center
218 Driveway
Fairbanks, AK 99701
(Information and speakers may be available from the organization.)

Lesson I — Air Pollution - Introduction

Objective: Students will be able to write, to the satisfaction of the teacher, a concise definition of air pollution in which health problems are identified as a major concern.

Materials: film list
1 student response sheet:
"Air Pollution and Energy Consumption" (pg. 53)

Introduction: The concept of air pollution will most likely be familiar to students of high school age. The range of understanding, however, will differ greatly according to the varied experiences of each individual. An overview of the problem will provide a starting point that will be common to all students as well as provide a focus for future information.

The overview should broadly cover the subject of air pollution. This can be accomplished by one of the suggested films, a guest lecturer with personal knowledge in the area, a reading from one of the books in the bibliography, or a research project in which the students define the problem.

In presenting the introductory material the students should be realize that the problem of air pollution is related to human needs and dependence on advanced technological innovations. The production of modern conveniences has created unsuspected health hazards in the release of potentially dangerous chemical wastes. The student response sheet which is provided can be used to focus attention on the relationships between air pollution and our use of modern technology. This response sheet may be used with whatever instructional strategy is available.

The following film list represents the films available from the Alaska State Library on the subject of air pollution. The various films present different aspects of the problem. Each is capable of providing a basic overview and is therefore a valuable tool for introducing the subject of study.

FILMS

(films) 40509 Air is for Breathing - 29 min.
Studies air pollution in the United States. Gives a reasoned analysis of what the main pollutants are and the principles that must guide a systematic and effective approach to pollution control. Illustrates the research that is improving our technical capability and some of the control measures being

implemented. Concludes with the message that air pollution is everyone's business.

32674 Air Pollution - Take a Deep Deadly Breath - 54 min.
Analyzes proposed solutions to urban air pollution problems.

20291 Pollution Solution - 15 min.
Discusses how LANDSAT'S remote sensing capabilities can aid in resolving environmental quality problems. Shows that the satellite can locate and monitor strip-mining operations to facilitate land reclamation programs, can help solve meteorological mysteries by tracking the path of airborne pollution and can monitor the course of industrial wastes and garbage dumped into our lakes, rivers and coastal areas.

10395 Tom Lehrer Sings Pollution - 3 min.
Presents a musical satire on the effects of air and water pollution.

30415 The Vehicle Emission Control Story - 22 min.
Shows the research being done by automobile manufacturers in vehicle emission control to reduce air pollution. Emphasizes the importance of keeping a car well tuned, and points out vehicle inspection procedures.

42430 What Are We Doing To Our World - 52 min.
Points out ways of conserving our natural resources. Discusses air pollution, the population explosion, land usage, waste disposal and insecticides. Defines ecology and studies the ecological problems of the Everglades, Aswan Dan and Panama Canal. From the Twenty-First Century Series.

Vocabulary Preparation: Pollutant
emission

Instructional Activities:

1. A) Begin the instructional session by surveying the class on their existing knowledge of the subject. Ask, "What is air pollution?"

   B) After gathering information on air pollution and briefly discussing what the students know, request each pupil to write a brief one-or two-sentence definition of air pollution. Keep these for the students to use in comparing their growth, after being given new information.

(new activity)

2. A) Inform the students that they will be learning about air pollution. In the first activity they will have to find and record information about specific pollutants, their sources, health effects, and why we have created them.

B) Distribute the student response sheets and direct the students to make a note of important information during the presentation. Be sure that the students understand the categories and what to listen for.

C) Present the introductory lesson (film, guest speaker, reports, lecture, or class reading).

D) Provide time to retrieve the information recorded in the students' notes and reinforce important points in the presentation.

E) Comparing student definitions of air pollution to new information which they have just been presented, ask the class how they might improve the definitions which they wrote.

F) Request the students to write a second definition using their new information.

G) Distribute the first definitions and compare how they have changed.

Additional Activities:

1. An additional Alaskan film source is:

Pictures Inc.
811 W. 8th Ave.
Anchorage, Alaska 99501

Air Pollution and Energy Consumption

Pollutant	source	human need	health effects

Lesson II — Pollutants and Sources

Objective: Following a reading of Health Effects of Air Pollution, the students will correctly complete all questions on a student response sheet.

Materials:
- 1 student reading material, Health Effects of Air Pollution (pp. 57-59)
- 1 student response sheet, "crossword puzzle" (pg 60)
- 1 student response aid - to be made into an overhead display or individually duplicated (pg. 62)

Introduction: The lesson will narrow the focus on pollution to five specific pollutants and their associated health hazards. There are many forms of air pollutants but the five major types which are important to Alaska's air quality are: carbon monoxide, particulate matter, hydrocarbons, sulfur oxides, and nitrogen oxides. Smog, an often mentioned form of air pollution caused by a chemical reation occurring in the presence of sunlight, is not considered a major problem in Alaska.

Listed below is a brief overview of the health and property effects of four of the five pollutants being discussed. The effects of hydrocarbons are not mentioned because the greatest danger they create are in the reaction with other pollutants that in turn have an effect on human welfare. More specific information is provided here than in the general treatment included in the student reading material.

Carbon Monoxide -
Physiological stress in heart patients; impairment of psychomotor functions; dizziness and headaches at lower concentrations; death at exposure to 1000 parts-per-million for several hours.

Corrodes limestone and concrete structures.

Particulates -
Correlated with increased bronchial and respiratory disease, especially in young and elderly.

Corrosion of metals and concrete; discoloring of surfaces; soiling of exposed materials; decreases visibility.

Sulfur Oxides -
Upper respiratory irritation at low concentrations; more difficult breathing at moderate concentrations, correlated with increased cardio-respiratory diseases; acute lung damage at high concentrations.

Corrosion and deterioration of steel, marble, copper, nickel, aluminum, and building materials; brittleness in paper, loss of strength of leather, deterioration of natural and synthetic fibers. "Burning" of sensitive crops.

Nitrogen -
Eye, nose and throat irritation when combined with sunlight to form photo-chemical smog; lung damage.

Corrosion of metal surfaces; deterioration of rubber fabrics and dyes.

The student reading material is not a comprehensive treatment of the entire problem. The illnesses and diseases mentioned are only the major health affects of each of the five pollutants.

Vocabulary Preparation:

respiratory	oxygen	nitrogen
fumes	oxide	nitrogen oxide
glacial	sulfur	carbon
asphalt	sulfur oxide	carbon monoxide
gas	bronchitis	particulate
asthma	emphysema	enemia
		asphyxiation

Instructional Activities:

1. The students will be aware of some specific pollutants and associated effects from their introductory lesson. Ask, "Can you name some specific pollutants? Why are these pollutants considered dangerous?"

2. Inform the students that in Alaska there are many types of air pollutants as everywhere on earth. There are five types found particularly in urban areas which have a greater potential effect on human health. They are carbon monoxide, particulate matter, hydrocarbons, sulfur oxides, and nitrogen oxide.

3. Tell the student that they will be learning about the five pollutants in today's assignment.

4. Distribute the reading material and give the student time to read the three pages.

Lesson II — Pollutants and Sources (con't)

5. The student response aid can be used if it is necessary to focus the group's attention on reading the material and learning the new information.

6. As they finish, distribute the response sheets which are in the form of a crossword puzzle.

7. Allow time to review student responses and reinforce the major concepts which have been introduced.

8. The student response aid can also be used as an overhead transparency or an individual sheet for review purposes.

Additional Activities:

1. Have students make a bulletin board display of "pollution facts".

2. Organize a research project to investigate each pollutant in more detail.

3. Invite a speaker (trade with another teacher) with a background in chemistry to explain to the class about the chemical nature of each pollutant.

Health Effects of Air Pollution

In this century, man has increased his productive capability a thousandfold. New industrial processes and technological inventions have improved our lives. But we are beginning to realize that the cost of this progress may also be heavy. People have under-estimated their abilities to damage the environment and threaten not only the welfare of themselves, but also the lives of their children.

One area of concern to all people is air pollution. Most of what we know about the effects of air pollution on human health we have learned in the last decade. And only in the last eight years have we begun to understand the way individual pollutants react with other chemicals to affect our health.

Scientists are convinced that air pollution is a very real contributing factor to the three major types of diseases that cause sickness and death -- heart disease, lung disease and cancer. Research has shown that air pollution will increase the rate of disease in those persons already afflicted, and earlier death is a real possibility.

The problem of air pollution is not limited to those persons who live in the cities or near the sources of pollution. Studies have shown that air pollution can actually be hazardous to people who live fifty or a hundred miles away from the pollution source. This is because some common pollutants are changed, while moving through the air, into more dangerous pollutants which attack our lungs and respiratory systems.

Although there are many kinds of air pollutants found in Alaska, the following five are more common and affect large numbers of people:

CARBON MONOXIDE -

Carbon monoxide is formed by incomplete burning of the carbon-containing materials: gasoline, wood, charcoal, paper, coal, etc. It is colorless and odorless. The largest source of carbon monoxide is automobile exhaust.

Carbon monoxide is inhaled through the lungs and enters the blood stream by combining with red blood which normally carries oxygen to the cells. The result is that the amount of oxygen getting to the cells in the body is reduced in the presence of carbon monoxide, and this can have a serious effect on our health. Carbon monoxide also disturbs heart function by weakening the contractions of the heart which supply blood to the various parts of the body. The effect of this on a healthy person is to reduce his/her ability to perform exercises; but in a patient with heart disease, it can cause death. A person who has a heart attack in the presence of heavy carbon monoxide air pollution is more likely to die than if the attack had occurred in clean air. And carbon monoxide is also harmful to persons who have lung disease and anemia.

Carbon monoxide can, in relatively small amounts, also affect mental function, visual perception, and alertness.

PARTICULATE MATTER -

"Particulate matter" includes a wide variety of compounds which may be further classified by size, chemicals and shape. Particle emissions are often classified as smoke, fumes, or dusts.

SMOKE is a visible product of incomplete burning. It consists mainly of small solid and liquid particles which are small enough to be suspended in the air.

FUMES are small particles emitted by any source which burns carbon-containing materials; for example, the processes used in the chemical, rubber, and metal industries. Fumes are gaseous when emitted but condense as they cool to form a liquid.

DUSTS are generally large solid particles which are typically a nuisance rather than a health hazard. They blow off fields, glacial sand deposits, unpaved roads, or cement, asphalt and lumber industries.

Particulate matter does damage to the linings of the lungs and throat. Such injury may be temporary or permanent. It may be confined to the surface. However, by weakening resistance to infection, such pollutants may affect the entire body. Chemicals carried into the lungs by particulates, for example, may cause cancer to develop on the lung lining, which then may spread throughout the body and prove fatal.

HYDROCARBONS -

Hydrocarbons are unburned fuels in gaseous or vapor form. They are made up of chemically combined hydrogen and carbon compounds. These enter the atmosphere from many sources, an important one being the unburned or partially burned gasoline from motor vehicle and stationary engine exhausts. Hydrocarbons are also emitted during the refining, storing, and marketing of gasoline products.

At the levels found in ambient air, hydrocarbons, as a class of compounds, may have no direct effect on human health. In an enclosed space, they could cause asphyxiation. Some are toxic themselves. However, this pollutant in sunlight reacts with other pollutants in the air and creates a smog-like situation which causes respiratory irritation and stinging, watery eyes.

SULFUR OXIDES -

Sulfur oxides are formed by burning sulfur and sulfur-containing coal, gas, or fuel oil for industrial heating, home heating, wood

pulping, refining, or for the production of electric power. Sulfur dioxide makes up about 95% of these gases and is a colorless gas with a suffocating odor. Sulfur oxides combine with moisture to produce sulfurous acid and the extremely corrosive sulfuric acid (hence the "acid rain" phenomenon).

NITROGEN OXIDES -

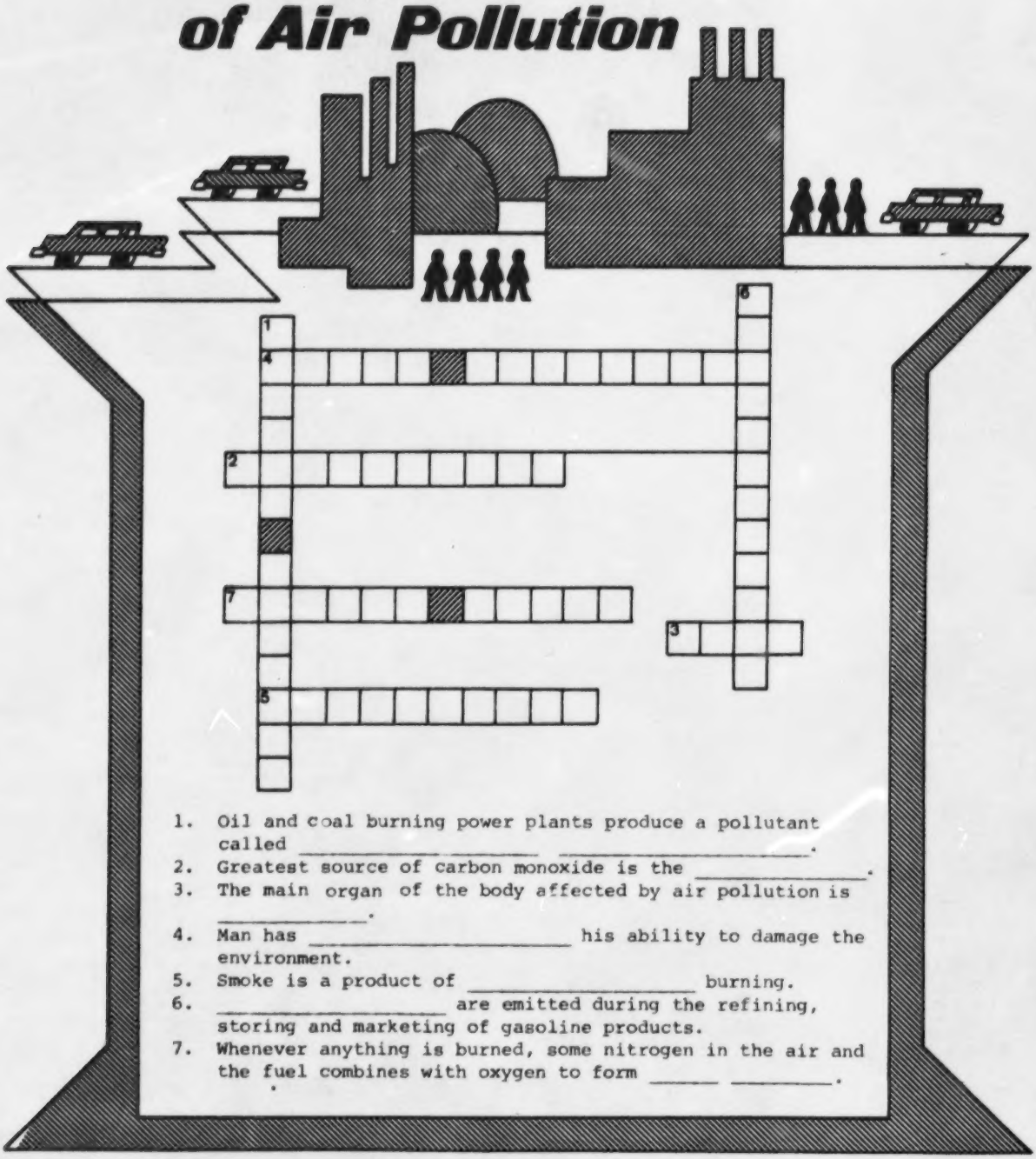
Whenever anything is burned, at a high enough temperature (above 650°C or 1,200°F) some of the abundant nitrogen in the air will react to, and combine with, oxygen to form nitric oxide. The latter gas is harmless but can combine with more oxygen to form another gas - nitrogen dioxide, (nitrogen dioxide is a suffocating, brownish-colored gas, and a strong oxidizing agent, quick to react with water vapor to form nitric acid). Furnace emission and exhaust gases from engines contain oxides of nitrogen.

Nitrogen oxides - These pollutants can effect lung tissue and lower the resistance of people to other types of illness. Hydrocarbons and nitrogen oxides combine in sunlight to cause eye, nose and throat irritation.

Note: Ice fog, familiar to Fairbanks and Anchorage residents, is not itself an air pollutant. But it can be the direct result of auto emissions and affect health and property. When the temperature is low enough, water vapor from combustion of hydrocarbon fuel or evaporation from an open pool of water forms ice crystals around particulate matter nuclei in the air. Motor vehicles provide a source of both the water vapor and the particles to serve as nuclei.

Ice fog directly affects health and property through accidents resulting from obscured visibility.

Health Effects of Air Pollution



1. Oil and coal burning power plants produce a pollutant called _____ _____ _____.
2. Greatest source of carbon monoxide is the _____.
3. The main organ of the body affected by air pollution is _____.
4. Man has _____ his ability to damage the environment.
5. Smoke is a product of _____ burning.
6. _____ are emitted during the refining, storing and marketing of gasoline products.
7. Whenever anything is burned, some nitrogen in the air and the fuel combines with oxygen to form _____ _____.

ANSWER SHEET

HEALTH EFFECTS OF AIR POLLUTION

1. Sulfur Dioxide
2. Automobile
3. Lung
4. Underestimated
5. Incomplete
6. Hydrocarbons
7. Nitric Oxide

Health Effects Of Air Pollutants

Directions: Use the information in the article entitled "Health Effects of Air Pollutants" to complete the table.

	Pollutant	Sources	Health Effects
1.	Carbon Monoxide		
2.	Particulate Matter		
3.	Hydrocarbons		
4.	Sulfur Oxides		
5.	Nitrogen Oxides		

Lesson III — Weather Inversions

Objectives: Students will be able to use factual information about pollution in creating plays which tell what it would be like to live through an intense weather inversion.

Materials:
- 1 student reading material, Weather Inversion (pp. 65-67)
- 1 student response sheet, "Weather Inversions" (pg. 68) (optional)
- 1 visual aid (can be made into a transparency for an overhead project or individually duplicated) "Temperature Inversion" (pg. 69)

Introduction: The students should now have learned many specifics concerning health problems associated with air pollution. They should have sufficient information to understand that air pollution poses a threat to human welfare. This lesson will inform the student of how weather factors can intensify concentrations of pollutants, increasing the chances of illness.

Although Alaska is sparsely populated and has few large industries it nonetheless has an air pollution problem. Weather conditions peculiar to colder climates intensify the problem. A phenomenon known as a weather inversion can trap the air around a city. When pollution from the city continues to be emitted into the stagnating atmosphere, the pollution level increases and the amount of pollutants inhaled correspondingly increases.

Included in the student reading material are two accounts of air pollution disasters which occurred as a result of weather inversions. The student reading material will explain what a weather inversion is, how it is formed, and the consequences of it happening in a heavily air polluted area.

Vocabulary Preparation:

inversion	environment	substances
concentration	phenomenon	attribute
basin	visibility	London
emission	stagnant	potential

Instructional Activities:

1. A) Ask, "What season of the year would you expect air pollution in Alaska to be the most dangerous?" (Winter)

B) Let the students guess, giving their reasons for their responses. Tell them that it is the winter months for two reasons. The first reason is that the winter conditions create a phenomenon called a weather inversion which concentrates pollutants in a small area. The second reason is that energy usage is greater during those months and consequently more pollutants are emitted into the air.

C) Tell the students that they will learn about a weather inversion in today's reading.

2. A) Tell the students that following the reading and a short discussion of a weather inversion they will work in small groups to create plays about air pollution. They will be expected to utilize some of the facts which they have learned in this and the past two lessons.

B) Distribute the reading material and have the students read in a way that best meets the needs of the group.

C) Upon completion of the reading assignment ask, "If the air quality in Alaska is good, why is the potential for air pollution so great?

D) Ask, "What is a weather inversion? What turns a normally occurring weather inversion into a dangerous situation?"

E) Ask, "What can people in cities do so that a weather inversion cannot create a dangerous situation?"

F) Organize the class into groups to plan, write and produce plays about polluion.

Additional Activities:

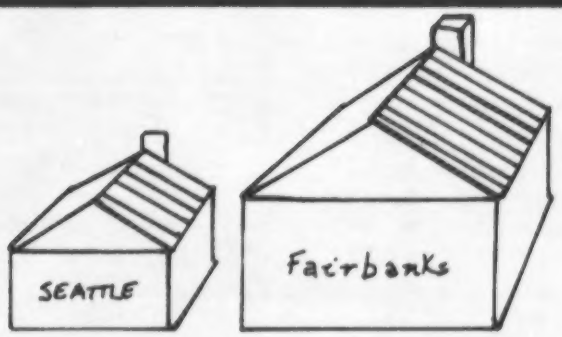
1. Share the plays with younger-aged children.

2. Write a science fiction story involving facts concerning pollution.

Weather Inversions

In general, the air quality in Alaska is very good, as there are few large industrial complexes or population concentrations. The existing industrial sources are isolated by distance and large mountain ranges into separate air basins. However, some change in the environment will happen as the population grows, more industries locate here, and the standard of living becomes higher with greater resource usage. Environmental problems are avoidable through good planning and wise use of our natural resources.

Although Alaska contains fewer people and more area than any other state, these few people tend to live in small "urban" areas, thereby concentrating the pollutant emissions into limited air spaces. More than half of the state's population live in the Anchorage area and more than three-fourths of the population live near the four largest cities. The average winter energy usage in Alaska is the highest in the world. Individuals here have a much greater impact on the environment than in other areas. The average home heating and household electrical usage is also much higher than in most other areas (see figure 1).



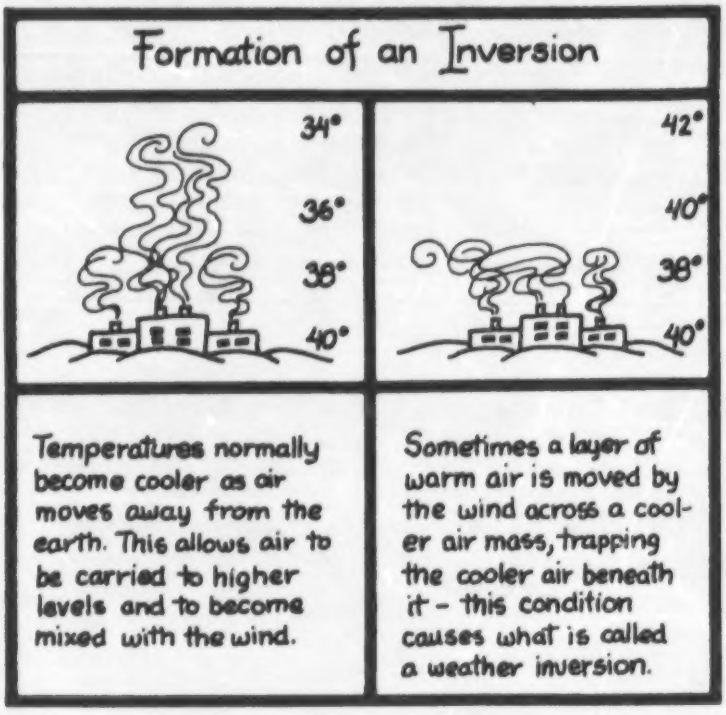
Comparison of Home Heating Energy Requirements

A house in Fairbanks needs 2.7 times more energy than a comparable house in Seattle to maintain a 68°F (20°C) inside temperature.

This high rate of pollution passed into the air is made even more dangerous during the winter months. A natural phenomenon known as a weather inversion can force the pollutants to lie in a thick mass close to the ground, thereby increasing the amount of dangerous materials entering a person's lungs.

Weather Inversions (con't)

The winter inversions which occur in Alaska are among the strongest found anywhere in the world. Strong inversions are formed when the ground surface cools faster than the overlying air, common in the sub-Arctic winter when there is little sunlight to heat the ground surface (see figure 2). The long winter nights make these inversion periods longer and create a strong potential for dangerous levels of pollution to last for several weeks.


Formation of an Inversion
34°
36°
38°
40°
42°
40°
38°
40°
Temperatures normally become cooler as air moves away from the earth. This allows air to be carried to higher levels and to become mixed with the wind.
Sometimes a layer of warm air is moved by the wind across a cooler air mass, trapping the cooler air beneath it - this condition causes what is called a weather inversion.

Weather inversions happen several times a year in cities throughout Alaska. So far there have been no massive deaths caused by these inversions. Other places on the earth have not been so fortunate.

On October 26, 1948, citizens of Donora, Pennsylvania, awoke to a strange dark morning. The various industries and businesses of the town were emitting their usual pollutants into the air. On any ordinary day, warm, light air rising from the ground surface carried such pollutants into the cooler atmosphere above. There they were blown away by prevailing winds. However, on this particular day, a blanket of warm air had formed above the cooler air mass covering the town. During the day, warm surface air and vapors produced by industries steadily cooled while rising. When this air reached the upper limits of the cold air mass, it was no longer lighter than the warmer air mass above. Unable to rise further, the contaminated air was trapped between the upper and

lower air masses. The cold surface air mass held the pollutants. Gradual cooling of the stagnant air mass resulted in a deposit of filth falling on the town. Within 48 hours, visibility was drastically reduced. Donora medical authorities were swamped with people suffering from a range of illnesses: stinging eyes, throat irritation, nausea, breathing difficulties, nasal congestion, and coughing. During the four long days that the deadly cover hung over Donora, almost 50% of the 12,300 citizens suffered illness. Before a heavy rain eventually cleared the air, death claimed 20 people and numerous animals, such as cats, dogs and birds.

What happened in Donora has happened for millions of years because it is a natural weather phenomenon. The danger in a weather inversion happening now is due to the fact that we pollute our air with tons of dangerous substances. Donora is only one example of the problem that faces us. There have been other times in other places on our planet where weather inversions and human-made pollution have caused people to become sick and contributed to an early death.

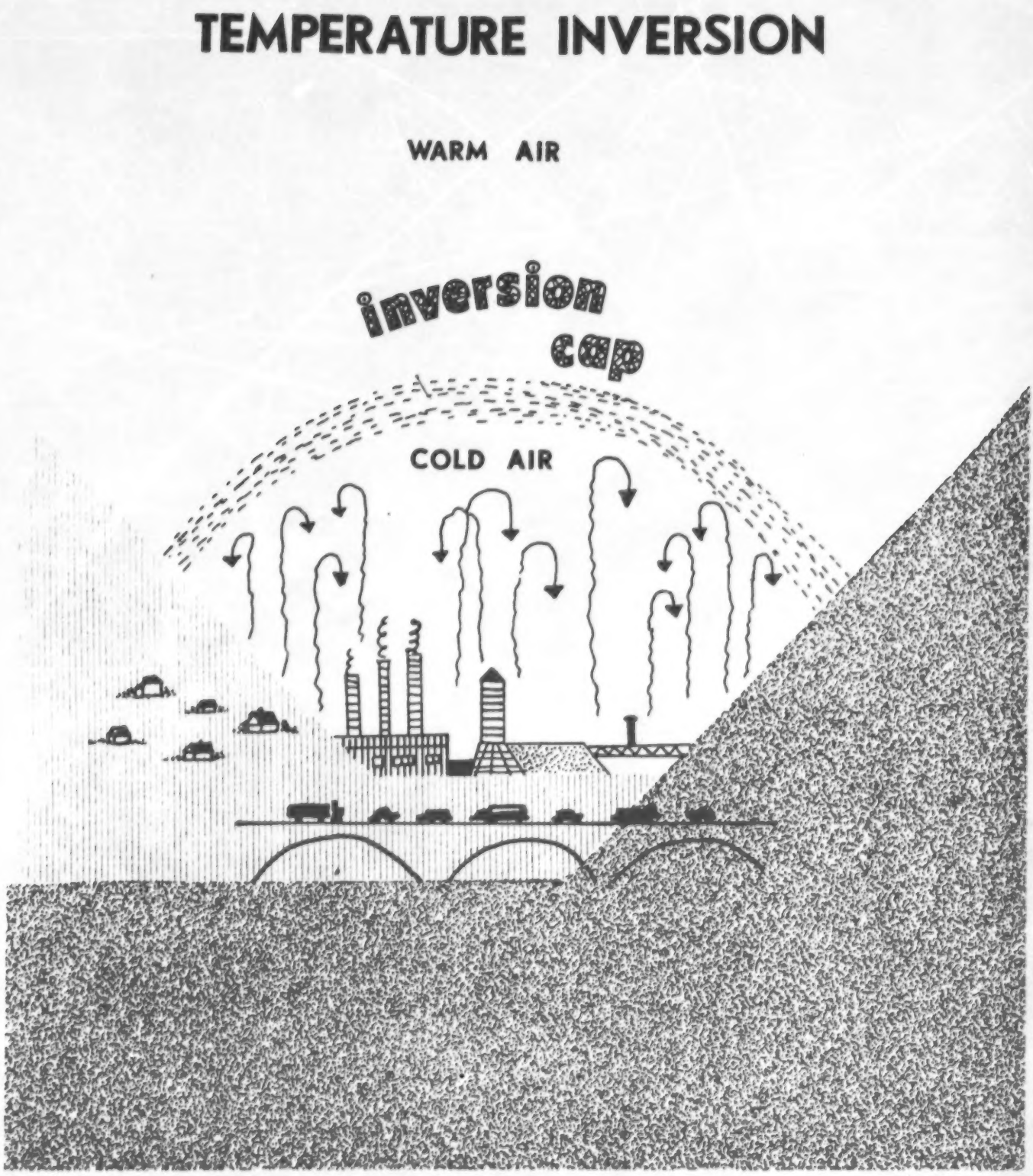
The worst recorded air pollution disaster took place in London, England, during December, 1952. A temperature inversion over the city produced a five-day nightmare. Steady contributions of soot and smoke from the coal-burning city reduced visibility to less than a yard. Before a passing cold air mass cleared the terrible smog, 4,000 people had died as a direct result of pollution. During the following two months, another 8,000 people died from illnesses directly attributed to this killer smog.

Nothing this serious has happened in Alaska. However, the conditions are here that make a serious problem possible. This is one of the reasons why people are concerned about the quality of air in our environment.

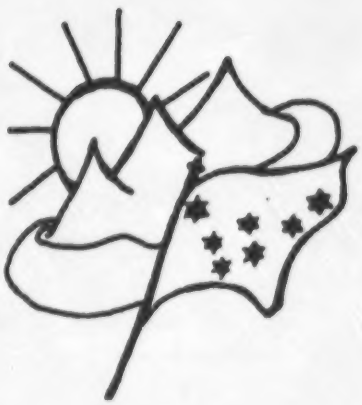
Weather Inversions

1) If the air quality in Alaska is good, why is the potential for air pollution so great?
2) How does the relatively small population in Alaska create a pollution problem?
3) Why is it that during the winter months air pollution increases?
4) To compound the problem of increasing pollution during the winter it is also the season in which weather inversions are frequent. What is a weather inversion? How is it formed?
5) What makes a weather inversion turn into a dangerous situation when it happens in an urban area during the colder months?
6) What can people in cities do so that a weather inversion cannot create a dangerous situation?

TEMPERATURE INVERSION



Lesson IV Cold Start Emissions



Objective: Using factual information concerning air pollution conditions in Anchorage and Fairbanks, students will be able to simulate a group of citizens trying to find a solution to city pollution problems.

Materials:
1 student reading material, Danger in the Alaskan Air (pp. 72-75)
1 student response sheet, "Danger in the Alaskan Air" (pg. 76) - optional
1 "Pollution Chart" (pg. 77)

Introduction: This lesson will provide factual information concerning air quality in Anchorage and Fairbanks. The material which the students will read begins by discussing pollution levels during the winter months. There are graphs included to demonstrate pictorially how concentrations of air pollution increase and decrease in relation to the cold weather. Identification of the major pollution source during cold weather months follows with a description of the automobile's role as polluter.

It is estimated that during the first 4-8 minutes of operation, as much as 92% of the total amount of pollutants may be emitted. Air pollutants produced during the time of engine warm-up are termed "cold start emissions". The production of large quantities of pollutants caused by warming up the car's engine coupled with weather inversion has the potential of creating a serious health hazard.

Vocabulary Preparation:

researcher	devices	concentration
estimate	analyzer	constant
alternate	vehicle	confined
technology	documented	
vehicle emission controls		

Instructional Activities:

1. Say to the class that everyone knows that automobiles are the major producers of carbon monoxide. Ask, "At what time during the operation of a car would you expect the car to produce the most carbon monoxide?"

2. Inform the class that in this lesson's reading assignment they will learn about something called "cold start emissions" and how these, along with weather inversions, create unhealthy air pollution conditions in Anchorage and Fairbanks.

Lesson IV Cold Start Emissions (con't)

3. Inform the class that following the reading and short discussion they will be asked to simulate a group of city people trying to solve the city air pollution problem.

4. Distribute the reading material and have the students read to find out what "cold start emissions" are.

5. Following the reading ask, "What is the major source of carbon monoxide?"

6. Use the graphs to reinforce the fact that dangerous levels of air pollution increase during the winter months.

7. Ask, "What are cold start emissions?"

8. Students should now be familiar with many facts concerning the potential threat of air pollution.

9. Set up a role-playing experience where a group of citizens must solve the air pollution problems which face their city. Choose students to play the roles of mayor, car distributor, environmental pollution specialist, oil company executive, city planner, a concerned citizen, ect.

10. Before the group meets, establish with the class what the perspectives of the role players should be. Let the class contribute to the development of the roles and the situation to which the players must respond.

Additional Activities:

1. Using the city newspapers in Anchorage and Fairbanks, keep a log of the pollution levels from day to day.

2. Have a student call the pollution control agency and keep a weekly (daily) record of air pollution levels.

Danger in the Alaskan Air*

Fairbanks, a small city with an urban population of approximately 35,000, has had a documented carbon monoxide problem since 1970. As shown in Figure 1, Fairbanks only has an air pollution problem during wintertime conditions, when extremely stable weather inversions are present during most winter days.

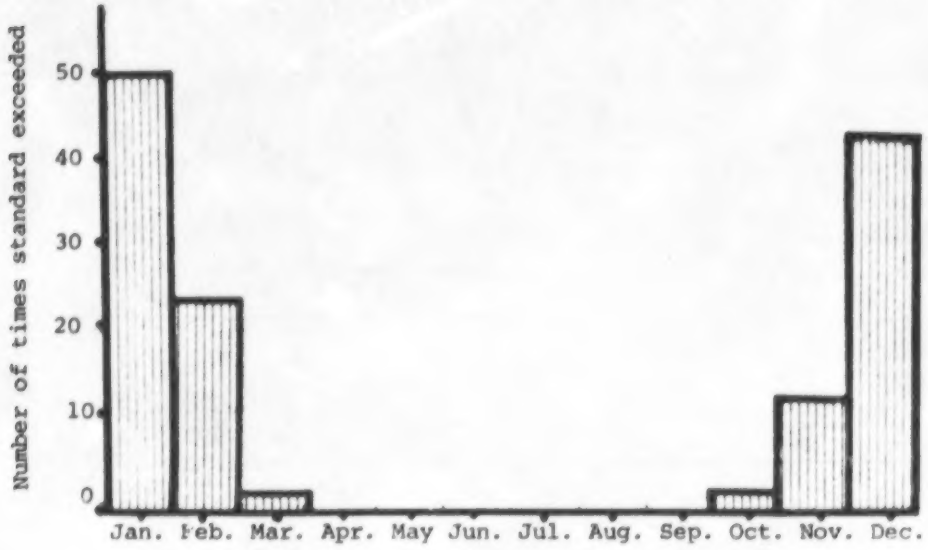


Figure 1 Number of times the 8 hour carbon monoxide ambient air standard was exceeded during the 3 year period, 1974-1976, in Fairbanks, Alaska.

Typical wintertime one-hour average carbon monoxide concentrations, as they vary throughout the day in the Fairbanks downtown area, are shown in Figure 2 below. There are several areas of importance in this curve. The concentration jumps, starting at about seven o'clock in the morning. It continues to increase until about 10-12 A.M. Between four and six in the afternoon the concentration increases quickly, even though traffic remains relatively constant, probably due to the afternoon cold starts downtown. Then from 10 P.M. until midnight the concentration steadily decreases.

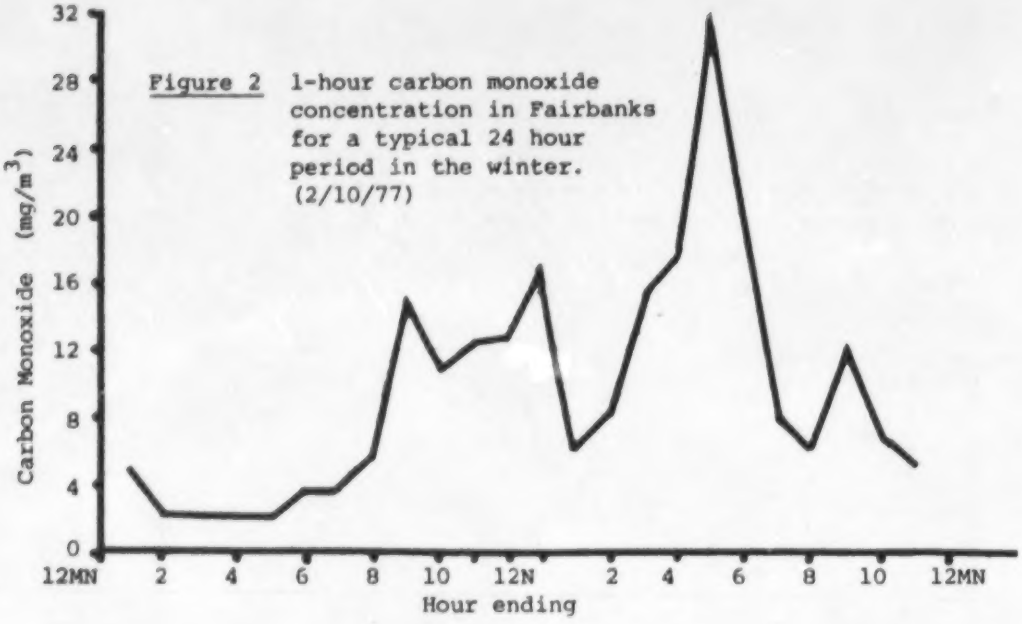


Figure 2 1-hour carbon monoxide concentration in Fairbanks for a typical 24 hour period in the winter. (2/10/77)

Anchorage, a city of nearly 200,000, has had a documented carbon monoxide problem since 1974. Figure 3 shows that Anchorage's carbon monoxide problems are confined to the wintertime.

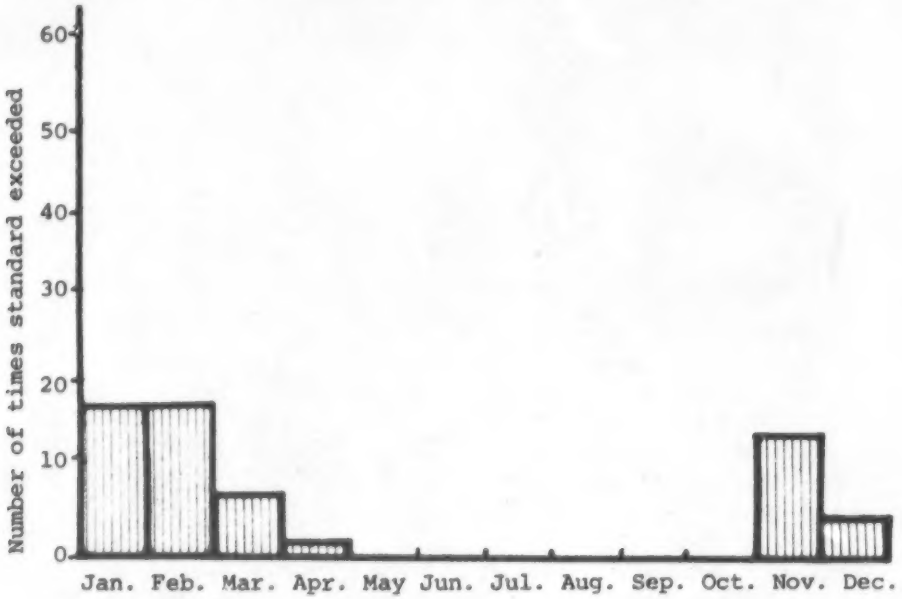


Figure 3 Number of times the 8 hour carbon monoxide ambient air standard was exceeded during the 3 year period, 1974-1976, in Anchorage, Alaska.

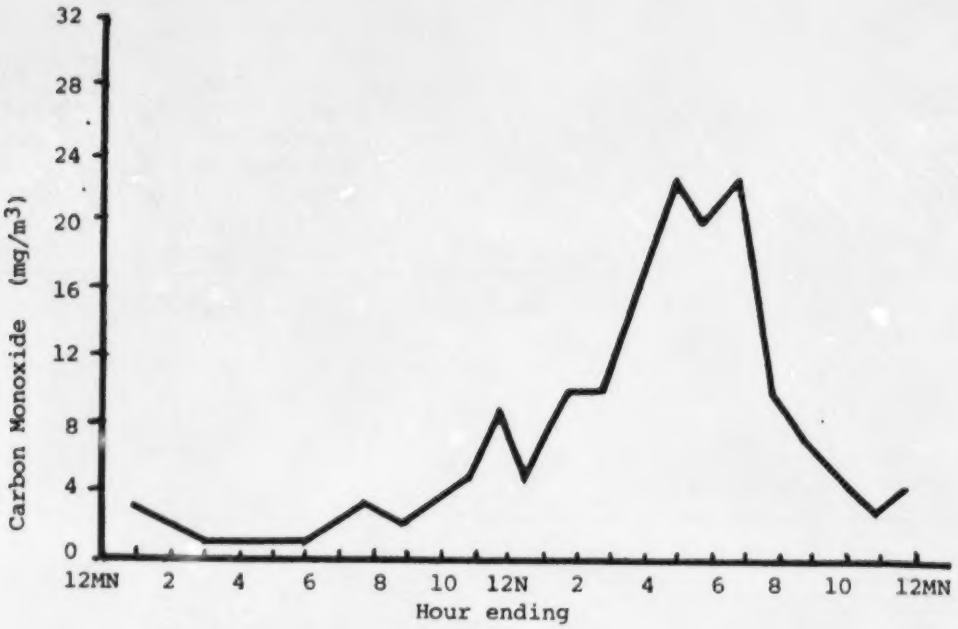


Figure 4 1 hour carbon monoxide concentration in Anchorage, Alaska, for a typical 24 hour period in the winter (1/10/78) when ambient air quality standards are exceeded.

Figure 4 shows a typical pattern of Anchorage's carbon monoxide hourly averages throughout a day in which the carbon monoxide 8-hour standard is exceeded. It is important to note that the continous carbon monoxide analyzer is located in the downtown central business district, and that high levels of carbon monoxide are only observed during strong wintertime inversions which are often coupled with very low wind speeds.

Virtually all the carbon monoxide is produced by automobiles. Even though vehicle emission controls have been required for several years, carbon monoxide levels have not shown a significant decline, partly because much of the carbon monoxide is emitted during the first four to eight minutes during which a car is warming up.

Since 1974, the state of Alaska has placed increasing emphasis on the importance of motor vehicle pollutant emissions during the first 4-8 minutes of operation in cold weather. The pollutants given off during this time are know as the "cold start emissions", and can account for the vast majority of all carbon monoxide emitted for the whole vehicle trip. Carbon monoxide

emissions during the engine warm-up period may account for as much as 92% of the total vehicle trip emissions.

Different researchers vary widely in their estimates of total carbon monoxide output during a vehicle trip. However, the estimated percent of total emissions due to cold start was high for all researchers. Such a high percentage suggests that even if the Federal Motor Vehicle Emission Control Program eliminates all carbon monoxide during warm vehicle operation, the total pollutant output from vehicles would not be greatly changed.

Alternate engine technology (in particular, the diesel and the Honda CVCC engines) reduces these cold start pollutants. Engine preheat devices also appear to be effective in reducing engine cold start pollutants, depending on how long the devices are used. The most effective are electrical plug-ins and automative start devices. A probable fourth method is regular engine tuneups and maintenance.

*Information and graphs in this reading selection has been taken from A Review of Carbon Monoxide Emissions from Motor Vehicles During Cold Temperature Operation published by the Department of Environmental Conservation in March of 1979.

Danger in the Alaskan Air

Answer the following questions in complete sentences.

1) What is the major source of dangerous substances in the Alaskan air?

2) Compare figures 1 and 3 on pages 72 and 73. What are the months of excessive pollution? Why is this so?

3) Compare figures 2 and 4 on pages 73 and 74. About what time do pollution emissions begin to build? About what time do they peak and begin to decline?

4) What are cold start emissions?

5) How important are cold start emissions to the overall problem of air pollution?

6) Should the government be involved in making sure cars are safe or do you think that individuals like yourself can take care of the problem?

Pollution Chart

Problems	Reasons	Sources	Solutions
dizziness, asthma, headaches, anemia, heart disease.	carbon monoxide	automobiles	
irritates eyes, nose, throat; damages lungs; kills plants; heart disease.	sulfur oxides	industry - coal & oil, burning power plants	
irritates eyes, nose, throat; affects lungs.	nitrogen oxides	industry	
cancer; respiratory problems.	hydrocarbons	automobiles	
carry poisonous gas to lungs.	particulates	automobiles, industry	
irritates eyes, nose, & throat, affects breathing, damages plants.	photochemical smog	gases & particles in air changed by the sun	

Lesson V — Pollution Control Problems

Objective: Students will be able to research pollution control problems related to their city and produce a report in written and oral form to the teacher's satisfaction.

Materials:
- access to telephone
- envelopes and stamps
- typewriter
- current names and addresses of local political figures
- addresses of environmental agencies
- telephone book
- 1 Discussion aid: "Pollution Chart" (see Lesson IV, pg. 77)

Introduction: Students have been presented with a variety of information concerning air pollution which began with a wide overview and gradually narrowed to specific Alaskan problems of air quality. The last lesson provides an opportunity for the student to become involved in finding solutions to meet the problems exposed in the past activities.

This lesson directs the students' focus to transportation-related problems primarily involving the automobile. On both a world-wide scale and in Alaska, the automobile is a major source of atmospheric pollutants. As was shown in lessons III and IV the emissions from automobiles are Alaska's potentially most dangerous health hazard.

The suggested research topics will require the students to directly contact people outside of school involved in the problem. The problem of air quality is real and as yet not a single solution or group of solutions has been effective in eliminating air pollution. The students will be reporting on aspects of a total solution which experts and concerned individuals are still seeking.

This research project will take several days to complete. The largest job will be in helping the students organize themselves to locate resources, setting up checks on their progress and establishing a procedure to complete their reports.

Lesson V — Pollution Control Problems (con't)

Instructional Activities:

1. To catch the attention of the class and prepare for the assignment, a provocative question might be asked. "Invisible gases are surrounding you which may be hurting your health. What can you do about it?"

2. Ask, "You have learned about many pollution problems. What do you think people can do or are doing to solve these problems?" Use the "Pollution Chart" (see Lesson IV, pp. 73 - 77) to stimulate discussion.

3. Inform the class that they will soon be involved in researching how people are reacting to air pollution problems. They will have to use resources outside of school which they will have to contact by telephone, writing letters or personally meeting.

4. The lesson can be accomplished individually or by small groups depending on the group's capacity to perform different kinds of tasks.

5. Some of the topics appropriate for air pollution solution research are:

   mass transit system (local)
   pollution control devices
   non-polluting car engines
   fuel saving car engines
   material laws concerning pollution control
   state laws concerning pollution control
   engine heating devices (for cold weather)
   automatic transmission vs. standard trans.
   appropriate student-selected topic

6. Establish a schedule with the students on due dates for choosing a topic, plan of action, written reports and oral reports.

CURRICULUM FEEDBACK FORM

Unit used_____ Grade Level _____ Name_____
Age Level_____ # of Children_____ Address_____
Type of Group (school class, scouts, etc.) _____
_____ _____
Approx. hours spent on unit_____ _____
Comments_____ _____
_____ _____
_____ _____
_____ _____

1. Background information was:	Just what I needed		I needed more
		unnecessary	
2. How many follow-through suggestions were used?			
3. Instructions were easy to follow?	yes___	no___	
4. Children were interested?	___	___	
5. Suggested discussion questions worked well?	___	___	
6. I will use this unit again	___	___	
7. I used other grade-level units to supplement the one for my group's age	___	___	

Please describe below any adaptations you made or improvements you suggest:

Please mail this form to the address listed on the back, and
THANK YOU VERY MUCH FOR YOUR HELP!

fold

(Stamp)

Information Office
Alaska Department of Environmental
Conservation
Pouch O
Juneau, Alaska 99811